POWER

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Define the Issues

WE are faced with the possibility of another coal strike.

On the one hand is a limited number of operators who have built a paper wall around the anthracite coal resources of the nation and called them theirs. They do not work them or allow them to be worked except upon their own terms.

On the other hand is a large body of miners who assume that they are the only people who are qualified and eligible to do the mining, and they will not keep at it unless their demands are complied with.

And between the two is the long-suffering public, filled with a vague consciousness that the coal was put there by divine forethought for their use and benefit; willing to pay the men who spend their days in the dark underground to win it, a wage commensurate with their toil and risk; willing to pay the men who have discovered and acquired the deposits and put their money and their executive ability into developing and operating them a fair interest on the capital invested and a generous profit on their initiative and enterprise; but full of the conviction that it is being exploited and with a growing determination that it will have coal whether or no.

This public has trusted everything that an assured supply of fuel at a reasonable price means to it, to the present system. It has believed that the development and operation of this basic national resource can be better and more efficiently carried on by private initiative and corporate management than by any other method through which the people can operate collectively to the same purpose.

It is for those to whom this function has been entrusted, miners as well as operators, to demonstrate, in this crisis, whether the system will continue to work—or rather whether it will return to working, for it has not worked lately to the public satisfaction.

And if the operators and the miners cannot agree, the public is entitled to know just what are the points at issue and to judge whether they are of sufficient moment to warrant the sacrifice and suffering which a strike involves upon its part.

And if they cannot agree or if an agreement can be reached only upon such terms as mean unreasonable advantages to them or either of them at the expense of the public, there may arise one who is gifted enough to make articulate the growing dissatisfaction of this great third party to the controversy and strong enough to put it into effect.

Electrical Features, Northeast Station, Kansas City

Generating unit of 30,000-kw. capacity served by vertical condenser with special facilities for cleaning and efficient combination of circulating pumps. House turbine used for emergency auxiliary drive. New layout of electrical system serving auxiliaries and improved monolithic bus cell structure.

AT NORTHEAST STATION, Kansas City, the new generating unit, shown in the foreground in Fig. 1, is rated at 30,000 kw. at 90 per cent power factor. To conform with the initial unit group of three 20,000-kw. machines, it delivers three-phase 60-cycle current at 13,200 volts. The unit has a direct-connected exciter and is provided with an air washer to clean and cool the air used for generator cooling.

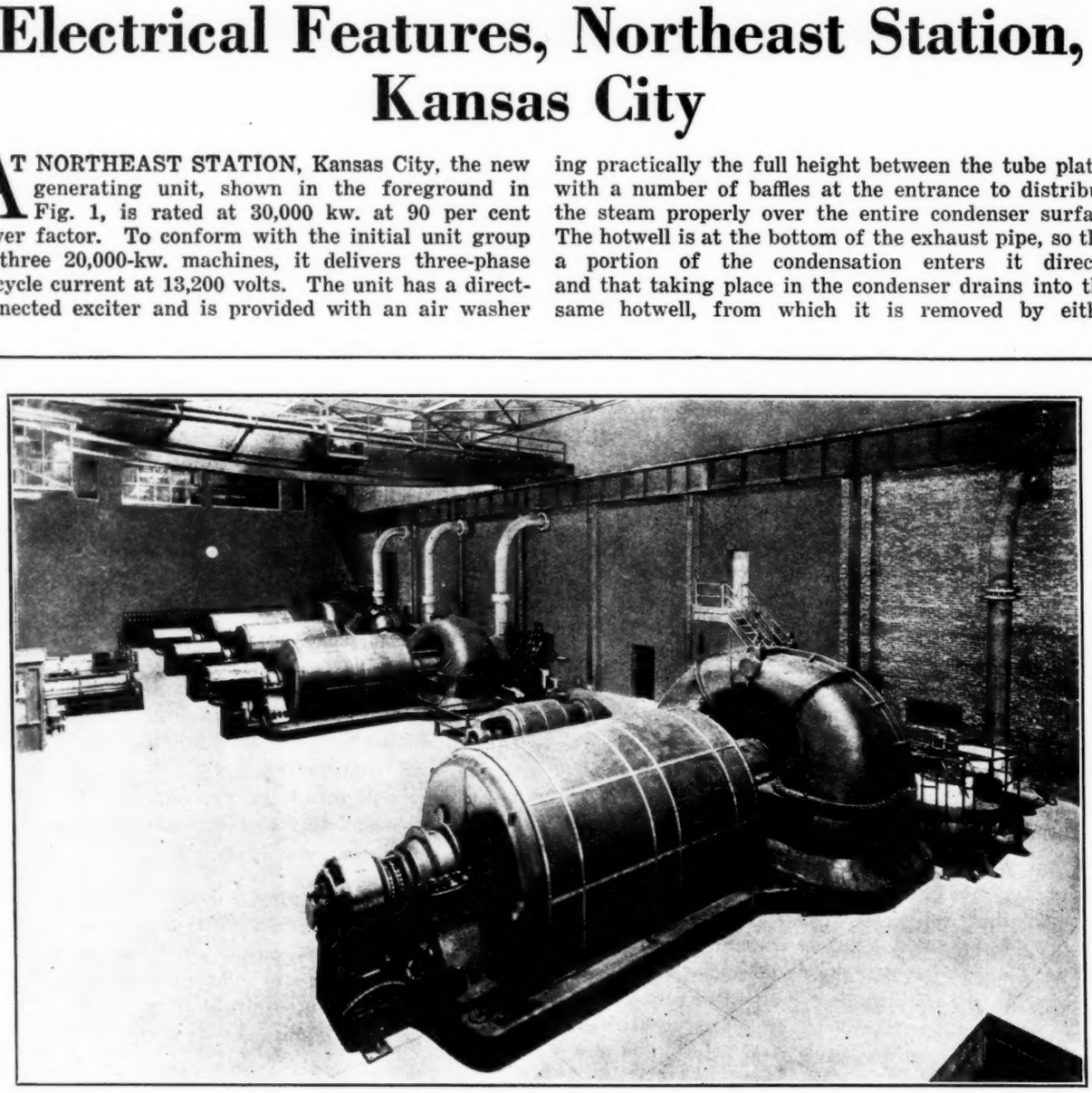


FIG. 1—TURBINE ROOM WITH NEW UNIT IN FOREGROUND

To allow for the great difference in river level and to minimize the pumping head on condenser cooling water, the condensing equipment has been located in a well 70 ft. in diameter and 57 ft. deep below the turbine-room floor. The condenser for the new machine is of the vertical two-pass type containing 45,000 sq.ft. of surface with a steam-condensing capacity of 350,000 lb. per hour, which reduces to 7.8 lb. of steam per square foot of cooling surface.

From the turbine a vertical exhaust pipe 13 ft. in diameter extends to the bottom of the well, and the exhaust from this pipe enters the condenser through an opening extending practically the full height between the tube plates, with a number of baffles at the entrance to distribute the steam properly over the entire condenser surface. The hotwell is at the bottom of the exhaust pipe, so that a portion of the condensation enters it directly and that taking place in the condenser drains into this same hotwell, from which it is removed by either one of two motor-driven condensate pumps, one a reserve unit, and is passed on its way to the main feed-water storage tank, as previously explained.

Circulating water is drawn from the intake well built with the original installation to serve the first two unit groups. It was necessary to add only three traveling screens and the piping connections to the second condenser well. To give great flexibility in the volume of water pumped and at the same time maintain the economy throughout the range, two motor-driven circulating pumps have been installed, one of which is driven by a constant-speed motor and the other by a two-speed motor in which the change of speed is effected by a varia-

tion in the number of poles made possible by two separate windings. With these two pumps four different combinations, to meet the changes in load and the varying temperature of the river water throughout the year, are possible. For example, one pump may be operated at one-half speed, one pump at full speed, the two pumps may be operated one at full speed and the other at half speed, or both pumps may be operated at full speed. In this way a range extending from 17,500 to 50,000 gal. per min. in four steps, may be obtained, with practically uniform pumping efficiency, as with the two-speed motor no energy need be wasted in the control resistance.

Discharge water leaves the station by means of a tunnel, passing out to the river at a point below the motor-driven centrifugal pumps. The nozzles discharge into a tank in which the air is liberated and the water is again taken by the pumps and forced through the nozzles. To keep this water at a suitable temperature, a cooler is provided in the tank using a portion of the circulating water supply, or during the hot season, colder water from deep wells. The evaporation of this recirculated water, amounting to about 10 per cent, is made up under float control.

House Turbine as Emergency Auxiliary Drive

As the extension to the station included not only 50 per cent additional generator and feeder capacity, but also the installation of a 1,500-kva. 600-volt 60-cycle house turbo-generator, it became necessary to make a

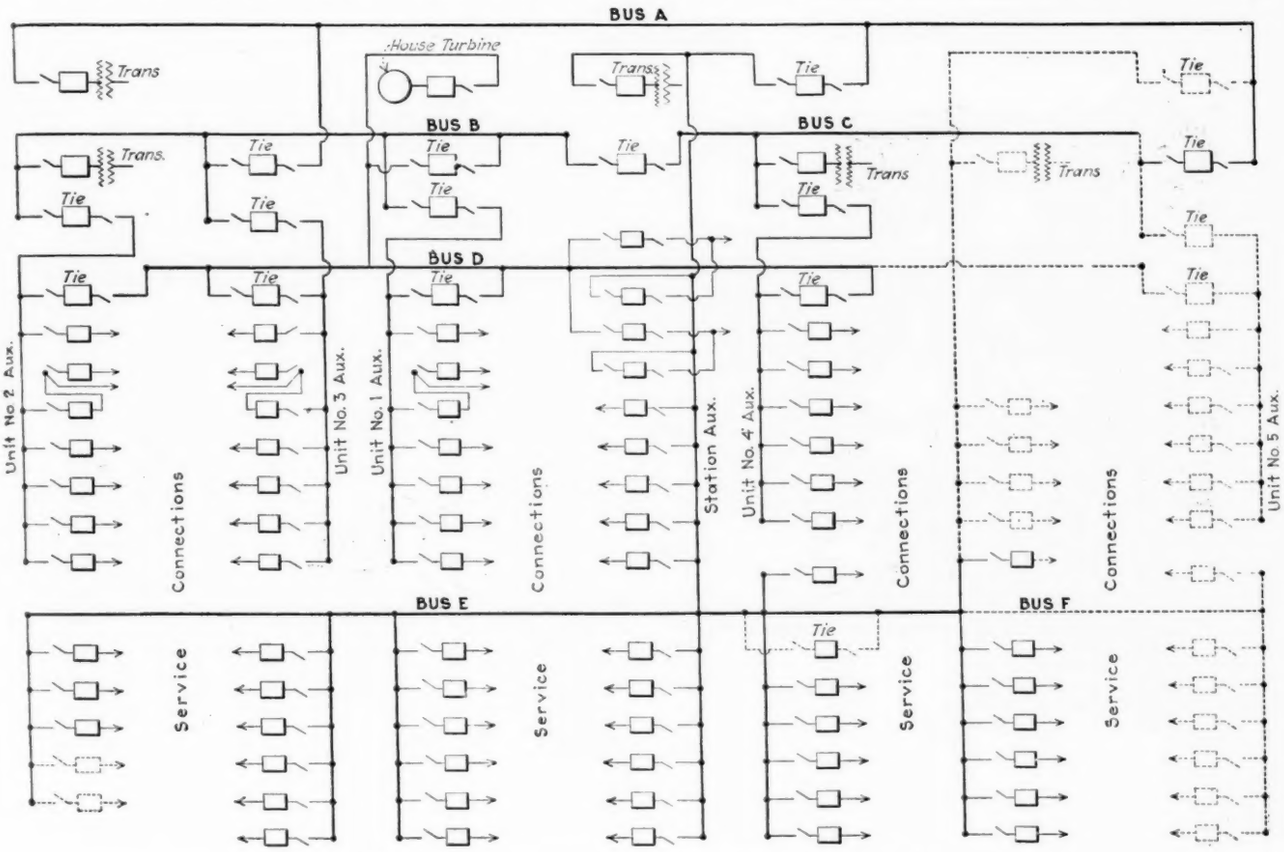


FIG. 2—PRESENT ARRANGEMENT OF 600-VOLT AUXILIARY SERVICE

intake. As the water carries a great deal of suspended matter, a sand pump has been provided to remove any accumulation that may collect in the bottom head of the condenser. Another provision has been made in the form of a butterfly valve in the dividing wall of the upper water-box, which permits flushing off the débris that may collect at the top of the tubes and tend to block the passage of the water. By means of a lever arm on a shaft passing through a stuffing box to the outside of the top water-box, this valve may be opened upon occasion, allowing the water to flush straight through the top head and carry away the débris into the discharge.

Owing to their relative simplicity and the fact that they utilize power at the water rate of the main unit, four hydraulic nozzles have been provided to remove the air from the condensers. The water for operating these nozzles is circulated through a closed system by

few changes in the original electrical layout of the station auxiliary system. Originally, this system was fed from five 1,800-kva. 60-cycle three-phase 13,200/600-volt transformers, and was intended to be operated as a unit system; that is, the auxiliaries for each generator were connected to a 600-volt unit bus and switch rack, with a separate transformer feed in each rack. A reserve bus and reserve transformer were provided for emergency, making it possible to operate transformers in parallel or to feed any switch rack from the reserve transformer.

In case of a total shutdown of the station and the 13,200-volt system, an outside source of power was necessary to start the main auxiliaries before the turbo-generators could be brought up, or one of the main turbines run non-condensing. Fig. 2 shows the 600-volt auxiliary system as it is now laid out. The house turbine will be operated as a synchronous motor and in

connection with a selected load in the following described manner, to furnish just such an emergency feed.

At a predetermined voltage, say 60 per cent of normal, if trouble occurs on the system, an undervoltage relay will trip a tie switch between the house turbine bus and the transformer bus. This operation will leave the main auxiliaries of one unit connected to the house turbine on an isolated system. In the meantime, when the frequency of the system drops to 55 cycles (60 being normal), the house-turbine governor valve is automatically opened and the auxiliaries of the selected units kept running, which in turn will allow the selected main units to be closed back to the main or reserve bus if the cause of the trouble has been cleared. The selected load may be the auxiliaries of any one or any two generators, as the house turbine has sufficient capacity.

This scheme of house-turbine operation, that of normally operating the generator as a synchronous motor, of course necessitates running the turbine rotor in an empty casing. The turbine wheels, which would soon become excessively hot from windage losses, are cooled by a small amount of saturated steam passed through the turbine, which later serves the purpose of heating the makeup water.

The control switchboard for the house turbine and auxiliary system is shown at the left in Fig. 3. From this board are controlled both primary and secondary oil circuit breakers of the five transformers and the 600-volt bus tie switches, all of which are connected for synchroscope operation. Originally, the auxiliary system was not grounded, but this has since been changed by grounding the neutral point of the star on the 600-volt side of the transformers and also the neutral of the house-turbine generator.

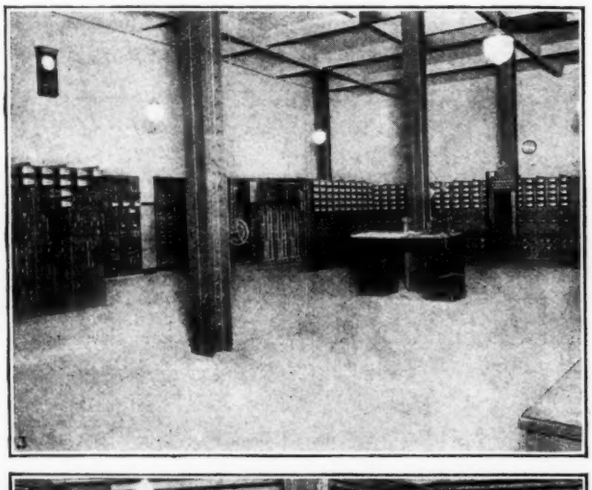


FIG. 3—HOUSE TURBINE AND 600-VOLT AUXILIARY BOARD AT LEFT AND OLD FEEDER BOARD AT RIGHT

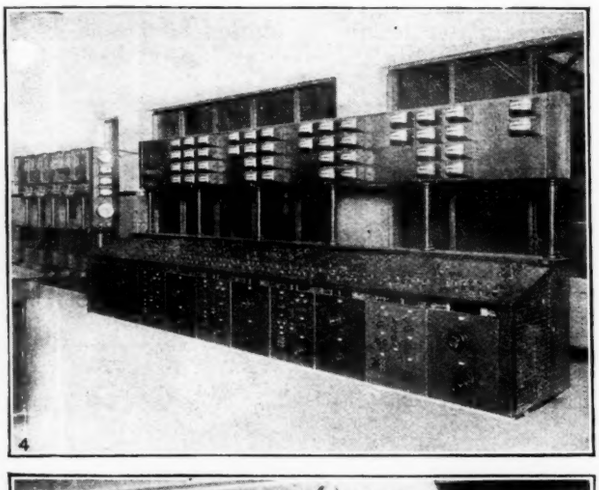


FIG. 4—GENERATOR BENCHBOARD AND AUTOMATIC VOLTAGE REGULATORS FOR GENERATORS AT EXTREME RIGHT

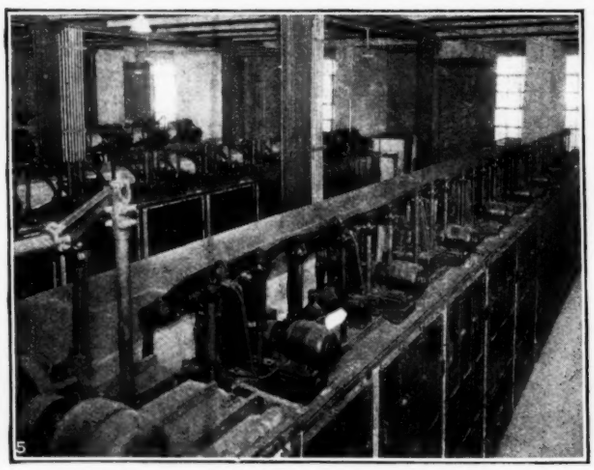


FIG. 5—OLD BUS AND OIL CIRCUIT BREAKER STRUCTURES

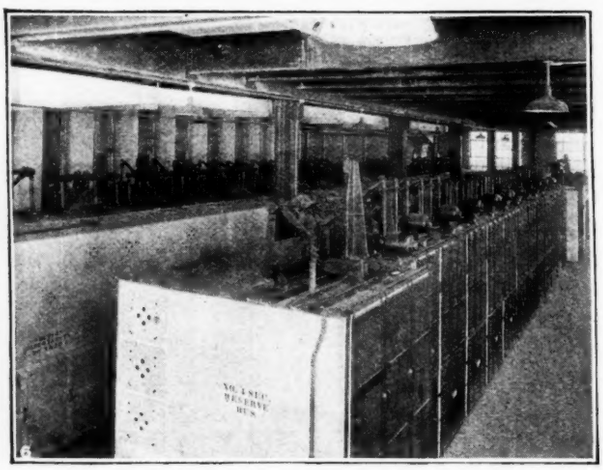


FIG. 6—NEW BUS STRUCTURES. RESERVE BUS IN FOREGROUND AND MAIN BUS IN REAR

Extensions to 13,200-Volt Bus and Feeder System

In the high-tension bus and feeder layout in the new extension, some improvements that may be of interest have been incorporated. The new switchhouse is only half as large as the first one, but it will accommodate the same generator capacity and 85 per cent as much feeder capacity. This saving in space was accomplished by a rearrangement of the bus structures and by the elimination of a special floor used in the old building

for the routing of secondary and control wiring conduit. This allowed an additional floor for oil circuit breakers and for station office room.

The old bus and oil-circuit-breaker cell structure was built up of precast concrete sections. It was decided to make the new structure monolithic, and Fig. 6 indicates that the results were quite satisfactory.

A view of the old bus and oil-circuit-breaker structures is shown in Fig. 5. The oil-circuit-breaker mechanisms are set below the level of the top and backed up against the bus compartments. The cleaning, repairing and adjusting of the mechanisms set in this position were difficult. In the new construction this fault was overcome by raising the switch cells to the same level as that of the bus compartments, as shown in Fig. 6. The sub-cell disconnect switches were elevated with the oil circuit breakers, allowing the standard apparatus to be used.

Fig. 4 shows the benchboard, the control for generators Nos. 1, 2, 3 and 4, and the emergency excitation control for the battery and steam exciter. At the extreme left are the automatic voltage regulators for the generators.

DATA ON NEW UNIT, CONDENSER AND AUXILIARIES

PRIME MOVER—UNIT No. 4

Manufacturer	General Electric Co.
Type	17-stage Curtis
Capacity, kva.	33,333
Speed, r.p.m.	1,800
Pressure at throttle, lb. gage	250
Superheat, deg. F.	250
Type of generator	3-phase, 60-cycle, 13,200 volts
Ventilating air, cu.ft.	80,000
Exciter, direct-connected, kw.	175
System lubrication	Batch—filtration—Turner Filter
Air washer, 80,000 cu.ft.	Spray Engineering Co.

CONDENSER

Make	Worthington Pump & Mach. Corp.
Type	Surface
Tube surface, sq.ft.	45,000
Surface per kw. of generator rating, sq. ft.	1.5
Circulating Pumps:	
One Worthington 30-in. horizontal pump driven by 200 hp. constant speed induction motor, capacity	30,000 gal. per min.
One Worthington 30-in. horizontal pump driven by 200 hp. two-speed induction motor, capacity	30,000 gal. per min.
Condensate pumps, two, Worthington Pump & Mach. Corp., motor drive	100 hp.
Hydraulic air pumps, four	Worthington Pump & Mach. Corp.
Type of screens	Traveling
Number	5
Manufacturer	Link-Belt Co
Individual motor drive, hp.	5

New McClave-Brooks Mechanical Stokers

A new mechanical stoker in which is combined some features of the overfeed, and underfeed types and designed to meet the requirements of the different grades of bituminous and lignite coals, has recently been developed by the McClave-Brooks Co., Scranton, Pa. The coal is fed from a hopper on the front of the stoker and is pushed onto the grate by plungers so arranged that the coal is underfed for a distance of about two feet down the grate, or in other words, it is underfed into the coking and gas liberating zone of the fire, as in the regular types of underfeed stokers.

The plungers are operated mechanically and the length of the stroke is kept constant. The amount of coal fed is not varied in the usual way, by changing the length of stroke or the speed, but it controlled by a timer, which regulates the interval between feedings.

The stoker is equipped with a four-speed reduction-gear and is adaptable to steam engine, steam turbine or motor drive, the speed of which may be independently controlled thereby permitting further variation in operating.

A general view of the grate is shown in Fig. 2. The front section is equipped with sectional grates having horizontal air spaces designed to prevent sifting of fine coal. The main portion of the grate is fitted with a series of kicker bars, the movement of which is controlled automatically and is adjustable on the front operating shaft of the stoker. Provision is also made for operating the bars in sections so that any part of the fire can be worked independent of the remainder.

The front of the stoker is fitted with a special arch through which the secondary air is admitted directly

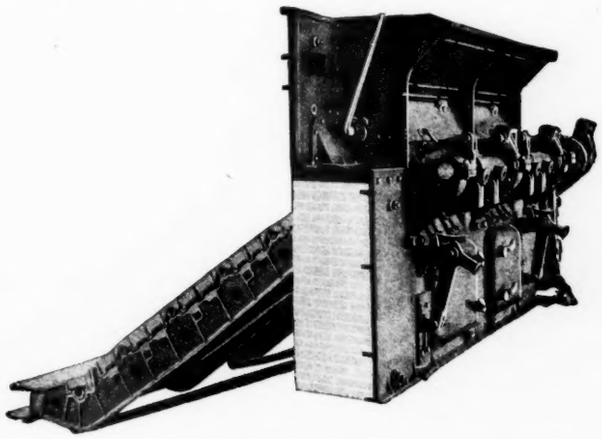


FIG. 1—FRONT VIEW OF POWER DRIVEN STOKER CONVERTIBLE TO HAND OPERATION

into the coking zone of the fire. This design eliminates the need for special arch brick.

An unusual feature is the provision made for operating the stoker by hand in case of emergency, such as power failure or other accident to the driving mechanism. By disengaging a clutch on the power drive, the plungers and kicker bar can be operated by hand

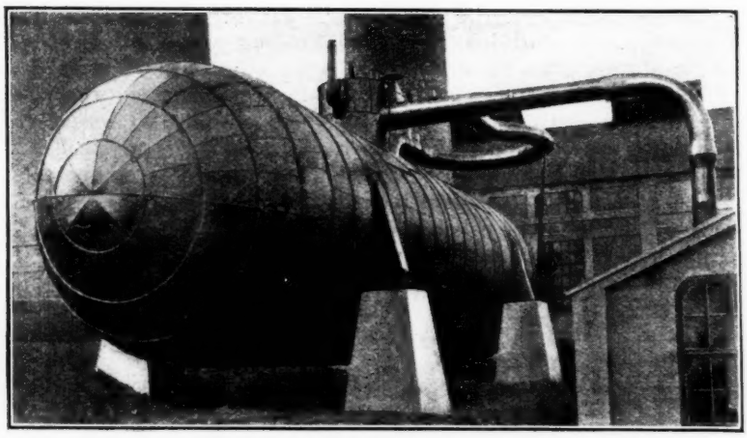
FIG. 2—VIEW OF GRATES AND KICKER BARS, ALSO PREHEATED AIR ARCH

and the stoker kept in service. Another feature is the provision made for raising the front doors for observation of the fuel bed or for working the fire as desired.

Additional equipment recently developed by this company include a hopper-feed hand stoker, a bagasse furnace, a wood burning furnace and an incinerator.

The hand stoker embodies most of the features of the mechanical stoker described in the foregoing, with the addition of special horizontal mesh coking plates used in the coking area in front of the grates.

The Steam Accumulator and Its Applications



The idea of using a large mass of hot water to store up the energy of excess steam is not new, but the practical application of this idea to steam at pressures considerably above atmospheric is a recent European development that is worthy of careful study by American engineers with particular reference to plants having a widely fluctuating process load. The present article describes the construction of the high-pressure accumulator and shows how weights, capacities, etc., are figured. A few of the many possible applications are then outlined.

THE idea of using a mass of hot water for the storage of steam in the form of heat is not new. For many years the Rateau accumulators have found extensive application, largely in steel plants, to store up the exhaust steam from intermittently operated back-pressure engines, and produce a fairly constant steam supply for low-pressure exhaust turbines. The high-pressure accumulator, while working on the same principle of steam storage, has only recently found general application in Europe and is still practically unknown in this country.

Before going into the detailed description of the construction and application of the high-pressure steam accumulator, it will be well to review briefly the old but fundamental principle of steam storage in hot water. This can be best illustrated by a specific example.

The small demonstration tank shown in Fig. 1, contains one pound of water. Valve *A* connects it with a steam main in which the pressure is 100 lb. gage. Assume that this valve is open. Then, for all practical purposes, the water will be at the temperature of the steam, namely 338 deg. F.

With the steam pressure constant (neglecting the small heat loss from the insulated tank) the weight and temperature of the water must also remain constant. In other words, the water will be in equilibrium with the steam, so that no water will evaporate and no steam will condense. The actual weight of the steam above the water is comparatively small and may be neglected.

Now, suppose valve *A* is closed and the outlet valve *B* is cracked slightly open. The steam at 100 lb. pressure will start to escape through the valve. This will lower the pressure a little. Instantly the water will start to boil, for its temperature cannot remain appreciably higher than that corresponding to the pressure, and the only way the temperature can be reduced is by the water giving up part of its sensible heat in evaporating a portion of itself. In round numbers, it requires 1,000 B.t.u. to evaporate a pound of water if the water is initially at the boiling point. One pound of water gives up one B.t.u. for every degree its temperature falls. So, roughly, if the temperature falls 10 deg. (which would require the pressure to fall from 100 lb. to 85 lb.) approximately 10/1,000 or one per cent of the water would be evaporated.

By allowing the pressure to fall to 50 lb., still more water would be evaporated. The total temperature drop from 100 lb. to 50 lb. would be 40 deg. (338-298), and the fraction evaporated, according to this simple approximate method of calculation, would be 40/1,000 or 4 per cent.

The evaporation for this pressure drop can be figured more accurately as follows: The first steam produced is saturated steam at 100 lb. pressure, and the last is saturated steam at 50 lb. The total heat of the former is 1,189 B.t.u., and of the latter, 1,179, giving an average of 1,184 B.t.u. per lb. as the total heat per pound of the steam produced. The weight of water at the start is one pound. Let S stand for the total weight of steam produced. Then the weight of water at the finish must be $(1-S)$ lb. Neglecting the small loss due to radiation, the heat in the water at the start is equal to the heat in water at the finish plus the heat in the steam produced.

At the start we have one pound of water at a temperature of 338 deg. From the steam tables the heat content of this water is 309 B.t.u. After the pressure has fallen to 50 lb., we have $(1-S)$ lb. of water at 298 deg. Each pound of this contains 268 B.t.u., so the heat in the water at the finish is $268\ (1-S)$, while the heat in the steam given off is $1{,}184\ S$. We may then write: $309 = 268\ (1-S) + 1{,}184\ S$. Solving, we find that $S = 0.0446$ lb., or 4.46 per cent of the original weight of water.

If we start with one cubic foot of water instead of one pound, the weight of steam evolved by a pressure drop from 100 lb. to 50 lb. would be: $0.0446 \times 55.8 = 2.5$ lb.[1]

It may be stated as a general proposition, that the weight of steam evolved by one cubic foot of water is practically in proportion to the temperature drop. Two things, therefore, are essential if any large-scale application is to be made of the steam accumulator as a "flywheel" for steam. One is a large capacity for water, and the other is a large permissible variation in pressure.

[1] At 338 deg. one cubic foot of water weighs 55.8 lb.

Fig. 2 shows, in cross-section, a large-capacity "Ruths" steam accumulator made by the Aktiebolaget Vaporackumulator of Stockholm, Sweden. The tank, a riveted shell of heavy boiler plate with hemispherical ends, is supported in a novel manner to be described later. The large pipe *A* serves to connect the steam accumulator to the sources of steam supply and consumption. When the pressure in *A* is greater than that

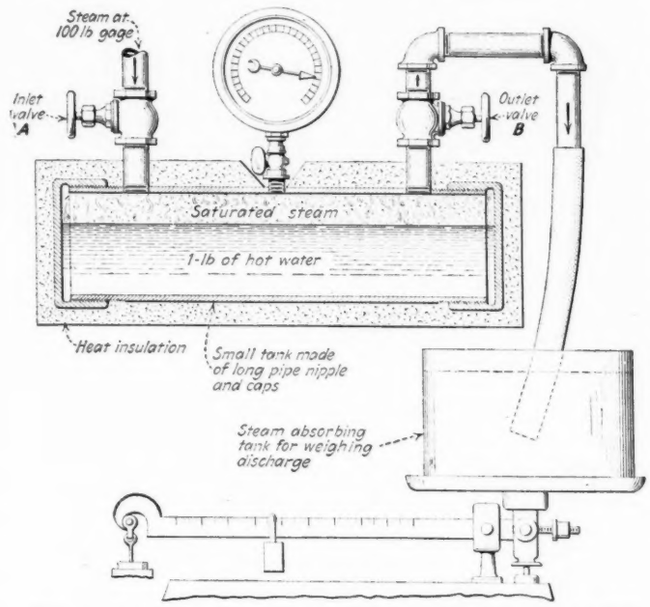

Steam at 100 lb gage
Inlet valve A
Outlet valve B
Saturated steam
1-lb of hot water
Heat insulation
Small tank made of long pipe nipple and caps
Steam absorbing tank for weighing discharge

FIG. 1—DEMONSTRATION MODEL OF AN ACCUMULATOR

in the accumulator, steam flows from *A* through the branch *B*, while when the pressure in *A* falls below that in the accumulator, the steam evolved passes out through *C* to *A*. The switching from *B* to *C* and back again takes place automatically, by means of non-return valves.

For example, when the accumulator is being charged, the steam entering through *A* and thence passing to *B* goes through the non-return valve *D*, then through the gate valve *E*, (normally kept open) down to the header *F*, to which are connected a large number of mixing nozzles *G*. The Venturi tubes shown surrounding these nozzles enable the latter to set up a rapid vertical circulation of water when the steam is admitted. Without these mixing tubes, it would be necessary either to locate the nozzles near the surface of the water, with a resulting large difference in temperature from top to bottom of the tank, or to place them near the bottom of the tank, which in turn would increase the necessary charging pressure by the amount of the head of water above the nozzles. The arrangement shown keeps this hydrostatic head under one pound, and at the same time assures practically uniform temperatures at all levels of the water.

When the pressure in *A* falls below that in the accumulator, the non-return valve *D* closes and the non-return valve *J* in the outlet opens. Steam, evolved from the water with a rapidity depending upon the amount by which the pressure in *A* is depressed below that in the accumulator, passes up through the discharge nozzle *K*, the open gate valve *I*, and the non-return valve *J* to *A*, whence it passes to the point of steam consumption. The expanding nozzle *K* serves to limit to any desired maximum the rate at which steam is evolved, and thus prevents priming which might be serious if the accumulator were subject to unlimited demands.

The water gage shown, at the right, is usually placed in some nearby building. Starting with a definite weight of water at a definite temperature and level, any increase in pressure raises the level for two reasons; the addition in weight by condensation, and the reduced density of water at the resulting higher temperature. Except for the gradual change produced by radiation and priming, the water level always returns automatically to the same point at the same steam pressure, so that water-level adjustments need only be made at long intervals. The water column is provided with a pressure gage and is itself graduated to read in terms of the usual corresponding pressure. Normally the readings of the two gages will go up and down together. If they gradually draw apart the water level is adjusted by special pumps provided for that purpose. Ordinarily this adjustment need only be made once or twice a month.

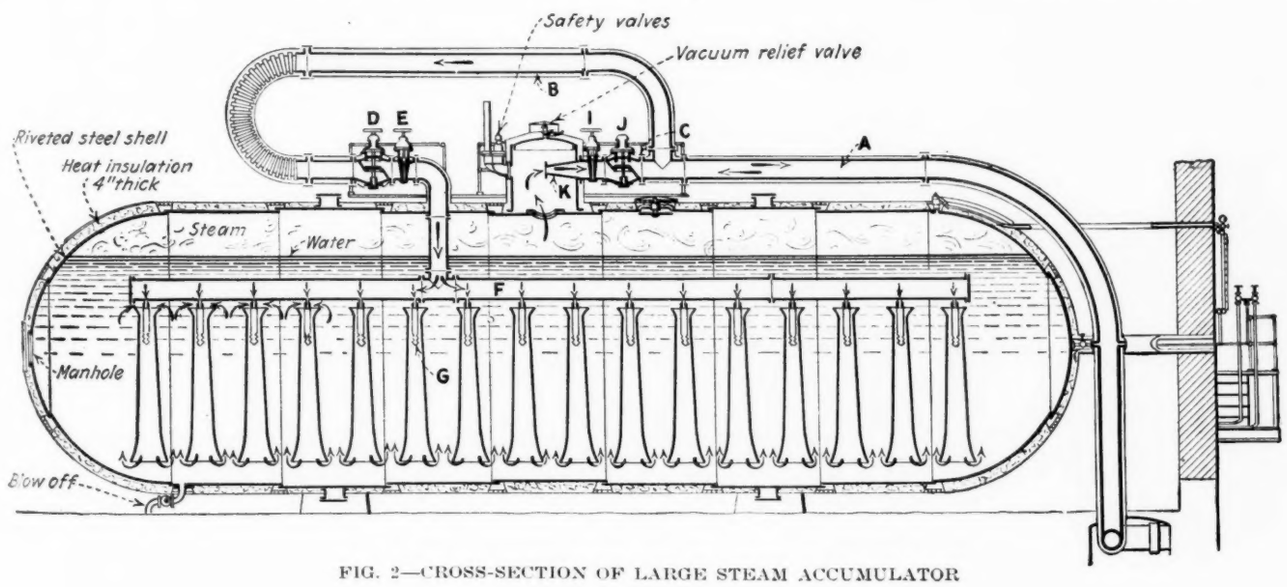


FIG. 2—CROSS-SECTION OF LARGE STEAM ACCUMULATOR

The fact that such accumulators are ordinarily very large and are often placed in the open air, sometimes leads to the conclusion that the amount of heat wasted by radiation must be enormous. That this idea is erroneous can easily be shown by a few simple calculations.

For example, consider the case of an accumulator having a capacity of 3,000 cu.ft. and an outside surface of 1,400 sq.ft. With insulation 4 in. thick the rate of heat transfer would be approximately 0.2 B.t.u. per square foot per hour per degree difference in temperature, or

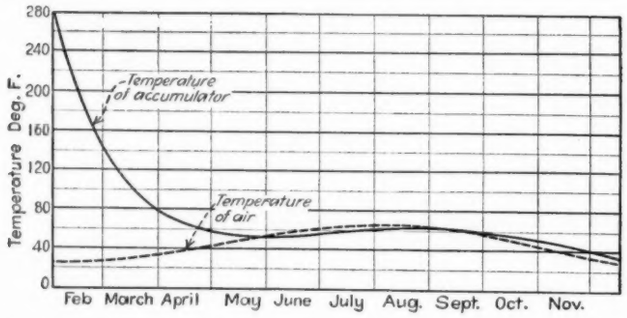


FIG. 3—COOLING CURVES SHOW THAT LARGE ACCUMULATOR SHUT DOWN FEB. 1 WOULD NOT FREEZE UNTIL FOLLOWING WINTER

1,400 × 0.2 = 280 B.t.u. per hour per degree difference in temperature for the whole tank. With a tank temperature of 338 deg. (corresponding to a pressure of 100 lb.), and an outside temperature of 55 deg., the total hourly loss would be 280 × (338 — 55) = 79,200 B.t.u., representing a waste of only about 8 lb. of coal, assuming that the coal contains 14,000 B.t.u. and is burned with an efficiency of 70 per cent. If all valves were closed with the accumulator pressure at 100 lb. and the outside temperature at 55 deg., the accumulator would start to cool off at the rate of about one half degree per hour. Even this low rate would steadily decrease as the temperature of the accumulator approached that of the surrounding air.

In this connection Fig. 3 is of interest. This shows the computed cooling curve of an accumulator of 12,200 cu.ft. capacity, erected at the Kaukas Cellulose Plant in Finland. Computations show that if this accumulator were shut down on February first, it would not freeze before December first of the following winter. This astonishing result is due in part to the enormous size of the accumulator, which has a diameter of 16.4 ft., a length of 63.3 ft., and can store 26,500 lb. of steam.

But while the rate of cooling depends upon the cubical contents of the accumulator as well as its surface, the actual loss of heat and of fuel, depends almost solely on the surface for given conditions of temperature, insulation, etc. Assuming an average temperature difference of 225 deg., a thickness of insulation of 4 in., a boiler efficiency of 70 per cent, and coal containing 14,000 B.t.u. per lb., the hourly radiation loss from an accumulator is approximately equal to one pound of coal per hour for each 200 sq.ft. of surface.

As the temperature in the accumulator varies, it is evident that expansion must take place in all directions. This must be allowed for in arranging the supports, which, at the same time, must be so located that they will handle the enormous weight with the least possible distortion of the shell. A rational arrangement of supports is shown clearly in Fig. 4. Support *A* only is fixed. Rollers at *B* and *C* permit motion in the directions shown by the arrows, while the motion at *D* may be in any desired direction, a pendulum support being used at that point. The normal expansion at *D* is, however, in the direction shown by the arrow, i.e., directly away from the fixed support *A*, as is the case at *B* and *C*. On account of the great weight of water carried, the supporting lugs are made of cast steel and designed to have a large bearing surface on the cylindrical shell.

For given proportions the total weight of steel plate required for the construction of an accumulator is roughly proportional to the product of the maximum pressure carried by the cubical capacity. For tanks with a length five times the diameter and for 100 lb. maximum pressure the constant is approximately 13 lb. of metal per cubic foot of tank capacity. Assuming the accumulator is 90 per cent full of water at 338 deg., it will hold 55.8 × 0.9 = 50 lb. of water per cubic foot of capacity, giving 13 ÷ 50 = 0.26 lb. of metal per pound of water. That is, the empty tank will weigh about ¼ the water capacity for a tank built for 100 lb. maximum pressure. For higher or lower maximum pressures the constant will be, approximately, ¼ multiplied by $\frac{1}{100}$ of the pressure.

To illustrate the application of this constant to practical problems, assume that it is desired to estimate roughly the dimensions and weight of an accumulator capable of storing 2,000 lb. of steam between the pressure limits of 50 and 120 lb. gage. The corresponding temperature range is 52 deg., and the average latent heat about 890 B.t.u., giving $\frac{1}{190}$ = about 0.11 per cent evaporation per degree or 0.11 × 52 = 5.7 per cent of the water content for the full temperature range. The necessary water capacity is therefore 2,000 ÷ .057 = 35,100 lb. The metal required at 120 lb. maximum pressure will be ¼ × $\frac{120}{190}$ × 35,100 = 10,500 lb.

At 50 lb. of water per cubic foot of total capacity the cubical contents of the accumulator would be 38,500 ÷ 50 = 770 cu.ft., corresponding to a shell about 6 ft. in diameter and 30 ft. long. In most cases met with in actual practice the tank capacity required for each ton of steam stored lies between 350 and 1,100 cu.ft.

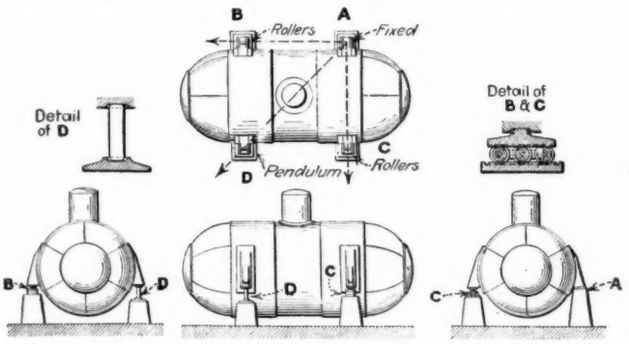


FIG. 4—METHOD OF SUPPORT THAT ALLOWS FREE EXPANSION

On a much smaller scale, the water spaces of boilers give the same effect as an accumulator. This effect is most pronounced with fire-tube boilers and in plants where a large variation in pressure is permitted. But, at the best, the accumulating effect of the water-storage space of boilers is measured in minutes, while that of a large accumulator may be sufficient to carry a heavy load for hours, provided the nature of the plant is such that a large fall in pressure is permissible.

From what has been said it is clear that the steam-storage capacity of an accumulator is practically proportional to the product of its volume in cubic feet by

the permissible temperature drop. The approximate constant is .06 lb. of steam per cubic foot of accumulator volume per degree fall in temperature. For an accumulator volume of 5,000 cu.ft. and a permissible temperature drop of 40 deg., the steam storage capacity is approximately $5{,}000 \times 40 \times .06 = 12{,}000$ lb. of steam. This weight of steam may be drawn off as rapidly as required. If the period of withdrawal is one hour the output of the accumulator is equivalent to that of a 4,000-sq.ft. boiler operating at rating.

It is not possible to give a similar factor for the steam storage capacity per cubic foot of volume per pound of pressure drop, because, starting with a given pressure

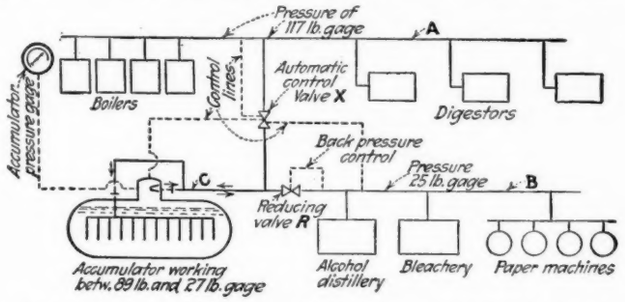


FIG. 5—APPLICATION OF ACCUMULATOR TO PLANT USING HIGH-PRESSURE AND LOW-PRESSURE PROCESS STEAM

the temperature falls slowly at first and then more and more rapidly as the pressure is reduced at a constant rate. This is clearly shown by the following table of corresponding pressures and temperatures.

RELATION BETWEEN PRESSURE AND TEMPERATURE

Pressure, Lb. Gage	Temperature, Deg. F.	Temperature Fall for 10 Lb. Pressure Fall, Deg. F.
120	350.1	...
110	344.2	5.9
100	337.9	6.3
90	331.2	6.7
80	323.9	7.3
70	316.0	7.9
60	307.3	8.7
50	297.7	9.6
40	286.7	11.0
30	274.1	12.6
20	258.8	15.3
10	239.4	19.4
0	212.0	27.4

Little has been said so far as to how the accumulator is fitted into the plant beyond the fact that it "soaks up" and stores excess steam when the pressure rises and gives it off again as fast as the pressure falls. No heat storage is possible without this variation of pressure at the accumulator. This does not necessarily or usually mean that the boiler pressure must be allowed to vary. In the majority of cases it is possible to so relate the accumulator to the rest of the plant that the boiler pressure is practically constant.

The steam accumulator in Europe has found its principal application in plants where large amounts of process steam are used in widely varying amounts, notably in pulp and paper mills.

The use of an accumulator permits of operating the boilers at a constant load with resulting simplicity and good efficiency. It also permits short peak demands of practically unlimited intensity.

Fig. 5 shows diagrammatically the installation at the A. B. Edsvalla Cellulose plant at Edsvalla, Sweden. Four boilers of 1,440 sq.ft. heating surface each and fired by wood waste deliver steam at 117 lb. gage to the high-pressure line *A* supplying the digesters. Another line *B* is maintained at a constant pressure of 25 lb. gage, and supplies an alcohol distillery, a bleachery and paper machines.

Between the high-pressure line *A* and the low-pressure line *B* is placed an intermediate section *C* connected to a Ruths Accumulator of 4,440 cu.ft. of volume and a storage capacity of 15,400 lb. of steam when working through the available pressure range between 89 lb. and 27 lb. Although the loads in sections *A* and *B* vary widely, and at different times, the boilers operate constantly at the average load, which is greater than the maximum demand of the digesters. The excess passes through valve *X*, which automatically maintains the pressure in *A* at 117 lb. The pressure in *C* ordinarily keeps between the limits of 89 lb. and 27 lb. Steam flows from *C* through the reducing valve *R*, which maintains a constant pressure of 25 lb. in *B* and supplies low-pressure steam in the exact amount demanded. When the amount of steam consumed by *B* is exactly equal to the excess from *A* passing through valve *X*, the accumulator lies idle at whatever pressure happens to exist in *C* at the moment this condition is attained. If the combined consumption of *A* and *B* falls below the boiler output, the pressure rises in *C* thus charging the accumulator. If the combined consumption rises above the boiler output, the pressure falls in *C* so that the accumulator discharges enough steam to make up the difference required by *B*.

The action may be more closely followed from the curves in Fig. 6 and Fig. 7. In Fig. 6, *A* is the consumption of high-pressure steam, *B* of low pressure and *C* the total consumption. *D* is the average of the total and also the constant load on the boiler plant, since the accumulator capacity is sufficient to take care of all fluctuations from the average.

In Fig. 7, curve *E* represents the distance from *D* down to *A* in Fig. 6. In other words it is the amount of steam passing through valve *X* as the excess of the

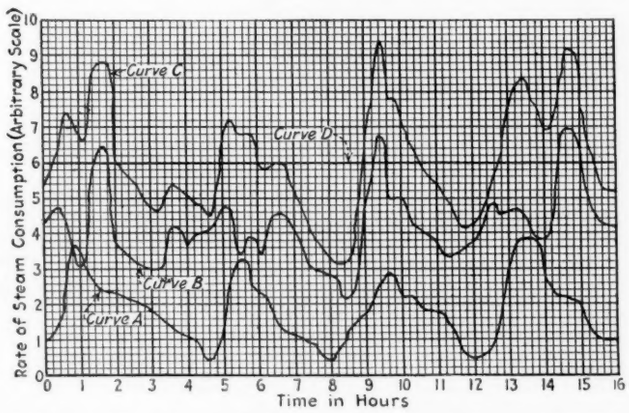

Rate of Steam Consumption (Arbitrary Scale)
Curve C
Curve D
Curve B
Curve A
0 1 2 3 4 5 6 7 8 9 10
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Time in Hours

FIG. 6—STEAM CONSUMPTION CURVES OF PLANT SHOWN IN FIG. 5

Curve A: High-pressure consumption. Curve B: Low-pressure consumption. Curve C: Total consumption. Curve D: Boiler plant output.

boiler output over the high-pressure consumption. Curve *B* repeated from Fig. 6, is the steam consumption of the low-pressure apparatus. Where *E* exceeds *B*, the excess goes to charge the accumulator, the corresponding area (cross hatched) being proportional to the weight of steam absorbed. Where *E* is less than *B* the deficit must be made up with steam given off by the accumulator. The corresponding areas representing the weights of steam given off during these periods are shown in solid black. The necessary size of the accumulator is determined by a study of these areas. It must be such that the pressure can rise and fall during the alternate periods of steam absorption and evolution,

without at any time exceeding 89 lb. or falling below 27 lb.

While the normal control of valve *X* is from the pressure of *A*, if by any chance the pressure in *B* should fall below 24 lb. valve *X* would open wider since the maintenance of the pressure in *B* is more important than in *A*. If, on the other hand, the accumulator pressure should rise above 89 lb., another control would close *X*, necessitating a reduction in the boiler output to keep the pressure from rising in the line *A*.

Since, in normal working, the boiler pressure remains constant regardless of the rate of steam consumption, the accumulator pressure gage is placed in the boiler room as a guide to the fireman.

In this, as in the majority of accumulator applications, the sole purpose has been to eliminate the variations in steam consumption. Among the advantages gained are

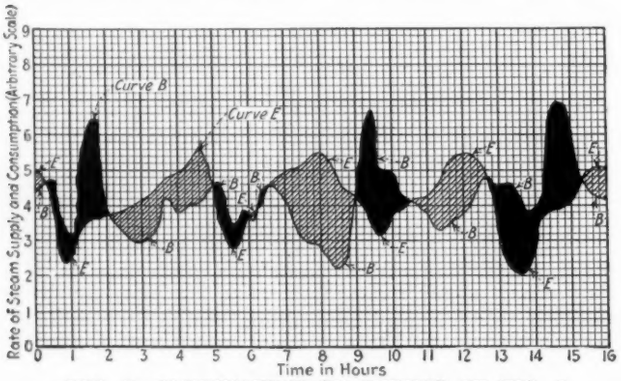


FIG. 7—COMBINATION OF CURVES OF FIG. 6

Curve B: Low-pressure consumption. Curve E: Excess of boiler output over high-pressure consumption. Cross-hatched Areas: Accumulator charging. Solid Black Areas: Accumulator discharging.

smaller boiler capacity needed and higher boiler efficiency (due to possibility of continuous operation at the most efficient load, absence of banking losses, ease of regulating dampers, etc., for maximum efficiency). There is also a commercial saving at the point of utilization due to the fact that the accumulator can easily supply any surge of steam caused by putting a cold piece of process apparatus suddenly on the line. Such apparatus may be heated up as fast as it will take the steam. In many cases this considerably increases the productive capacity of the manufacturing plant. The quality of the product is often improved as well because the operation of the apparatus can be determined solely on the basis of quality and quantity of production without considering boiler-room limitations.

There are a number of instances of small power plants in Europe using accumulators to carry peak loads or compensate for brief shortages of steam from the boilers. Accumulators have also been used in connection with electrically heated boilers and steam turbines for peak-load service in hydro-electric plants.

A third class of applications is that in which a cheap source of byproduct heat is available in variable amounts and cannot be as cheaply stored by other means. Examples are found in the use of gases produced as a byproduct in the manufacture of steel and coke.

The plant arrangement shown in Fig. 5, is only one of many possible combinations. The accumulator may be connected to the extraction point of a bleeder turbine or the receiver of a compound engine. All varieties of automatic control may be used. In fact so many combinations are possible that each plant must be treated as a distinct engineering problem.

Care of the Venturi Meter

By Claude C. Brown

Venturi meters should be taken out of service and cleaned at periodic intervals. The length of the interval is governed by the character of service in which the meter is used. The action of the venturi meter, depending as it does upon the differential between the line pressure and the pressure in the throat of the meter tube, is greatly affected by a variation in the throat area. For this reason any deposit that collects inside the venturi tube and in so doing reduces the throat area, tends to increase the velocity through the throat of the tube, and consequently raises the differential between the throat pressure and the line pressure.

The pressure differential, being the direct measure of the rate of flow of the passing fluid, is thus raised to an erroneous figure, making the meter read high. This trouble has been especially noticed in connection with the use of the venturi meter for the measurement of hot boiler-feed water which contains scale-forming salts. Salts such as calcium carbonate and sulphates tend to become deposited in a layer upon the inside of the throat of the tube, causing the error in measurement to increase as the thickness of the layer grows larger.

At the time that the tube is taken down for cleaning, the pressure leads to the register and recorder should be disconnected and flushed out. This is important for the reason that sediment and rust are bound to collect in these lines and any stoppage in either causes an error in the reading.

All leaks should be immediately taken up, both in the venturi tube and in the pressure leads. It is obvious that a leak in either of the leads will result in that line pressure being lowered. As the differential is small at best, any drop in pressure has a material effect upon the reading of the meter.

The best results are obtained if the two small pressure pipes that connect the meter tube with the recording and registering instrument are made of brass or copper, or other non-corrosive material. When installed, they should slant up or down grade and contain no summits or depressions where air or silt might collect. A valve should be placed on each pressure pipe close to the venturi tube. Connection between the pressure leads and the venturi tube should be made at the side of the latter and not at the top or bottom. If a summit or depression is absolutely unavoidable in the pressure leads, a blowoff valve should be placed at such a point.

In case the pressure pipes are extremely long, they should be made of ample size. If the length is 100 ft. or less, these should be three-quarters of an inch in diameter; if the length is in excess of 100 ft., one inch diameter pipe should be used.

Where venturi meters are placed in connection with reciprocating pumps, it is advantageous to install air chambers on the discharge of the pumps so that oscillations and pulsations of the pumps will be minimized. If this is not feasible, the meter tube should be located on the far side of heaters, filters or economizers, as these will then tend to reduce such pulsation.

Globe valves offer 15 to 40 times as much resistance to water as gate valves of the same size. The ratio increases as the sizes of the valves are increased.

War Department Turns to Fuel Oil

A High Record of Gross and Net Combined Boiler and Furnace Efficiency During a Twenty-four Hour Duration Continuous Test with Varying Loads

By W. W. BOWMAN*

ON OCTOBER 20, 1922, instructions were issued by Major W. A. Danielson, of the Quartermaster General's Office, at Washington, D. C., to Captain Robert B. Field, office of the Quartermaster Supply Office of the New York General Intermediate Depot, Army Supply Base, 59th Street and First Avenue, Brooklyn, N. Y., to convert three of their six 4,400 sq.ft. boilers from coal to fuel oil. The conversion required the following changes: (a) The installation of oil-storage tanks, service tanks, oil-transfer pumps and piping; (b) the changes in the boiler setting and baffling for the economical burning of fuel oil; (c) the installation of suitable and efficient fuel-oil burning equipment.

As it was apparent that the installation of oil-storage tanks of large capacity would require from sixty to ninety days, a temporary storage was arranged for by immediately providing ten government-owned tank cars to receive oil from a fuel-oil barge alongside, through

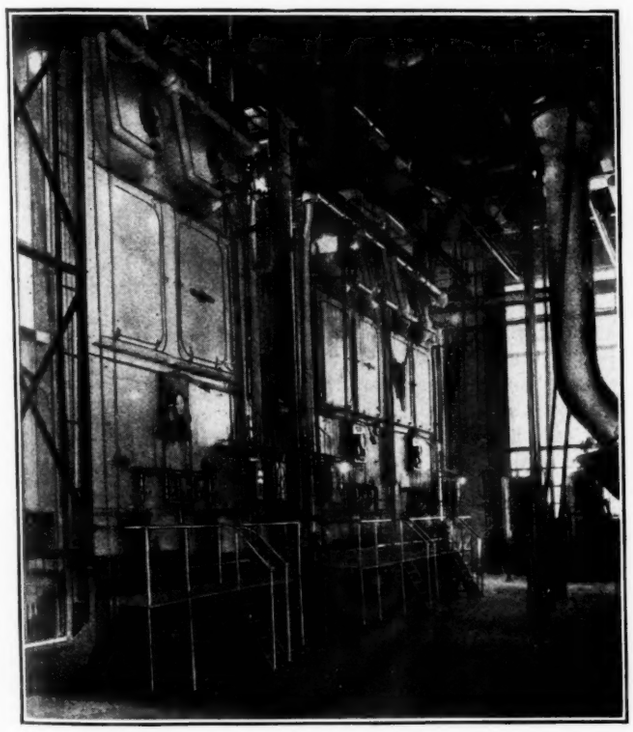


FIG. 1—FRONT VIEW OF THREE 4,400-SQ.FT. BOILERS CHANGED FROM COAL TO OIL BURNING

a temporary loading rack. A temporary transfer pump discharged the oil from tank cars into two temporary service tanks placed on the firing-room floor, from which the regular fuel-oil pumps supplied oil to the burners. By this means it was possible to burn fuel oil in one boiler Nov. 21, 1922, 32 days after instructions had been received from Washington to make the change. From Nov. 21 to Dec. 14, 40 per cent of the steam load was produced with oil, and on Dec. 14 the entire boiler power was produced by fuel oil.

Meanwhile plans had been made for the permanent arrangement, provisions being made for two steel

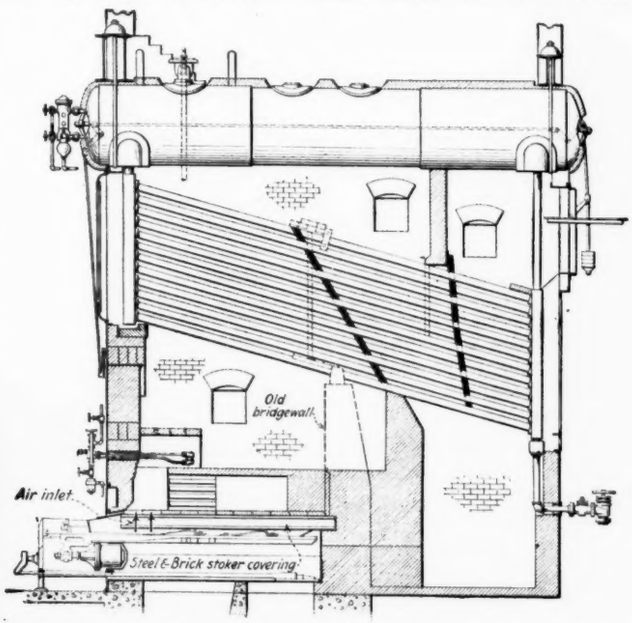


FIG. 2—SECTION OF BOILER SETTING SHOWING CHANGES MADE IN FURNACE AND LOCATION OF BRIDGE WALL AND BAFFLES

tanks having a combined capacity of 3,000 barrels, or 15 days' supply during the extreme load of the winter months; two 4,000-gal. steel service tanks to be installed on the basement floor, which is at the ground level; the necessary transfer pumps in duplicate and interconnecting piping, the lines from the main storage to service tanks being run in existing pipe tunnels under the yard.

The foundations for the main storage tanks were prepared by grading on filled-in ground with a sound bed under the tanks to prevent earth corrosion. A reinforced-concrete retaining wall four feet above ground level was erected to form a rectangular dike with a central partition between the tanks and of sufficient capacity to hold the oil contents of both tanks. A pumphouse 10x14 ft. of fireproof construction was erected near the main storage tanks to provide a place for the transfer pumps and all valves necessary for the operation of filling and emptying the storage tanks. The main storage tanks are near a slip in the bay, where oil may be received from barges and is approximately 200 ft. from the boiler room.

The six 4,400-sq.ft. Babcock & Wilcox boilers have a setting 12 ft. high at the front and 6 ft. high at the rear header, with a firebox 8 ft. wide and 7 ft. 7 in.

*Chief engineer, Army Supply Base, Brooklyn, N. Y.

long measured from the front wall to bridge wall, fitted with type E stokers, the grate bars of which were 3 ft. above the floor in the center. The baffle was of the standard vertical type. The forced-draft equipment consisted of electrically driven fans, which were augmented by one stack 165 ft. high, serving the six boilers.

It was decided to arrange the three boilers in such a manner as to obtain the highest efficiency with oil as a fuel without eliminating the stokers and without jeopardizing the coal-burning efficiency should coal be used again, and the changes in the settings and baffles were made with this important point in view.

The stoker was left intact with the exception that the small coal feeding hopper at the front was removed. The bridge wall was moved back 3 ft. 6 in. so as to give 11 ft. in the clear to the front wall.

The front vertical baffle was removed, and replaced by an inclined baffle extending up from the new location of the bridge wall to the top row of tubes at a point 6 ft. 6 in. from the front tube header. The rear baffle was also removed and installed back of the brick curtain wall, and slightly inclined to equalize the second and third passes at the bottom. The location of the old bridge wall and baffles is shown by the dotted line in Fig. 2.

Fuel-Oil Burning Equipment

A circular letter and specifications were issued Oct. 24, requesting bids covering fuel-oil burning equipment for the three boilers, installation to be made over the stokers and a protecting floor provided to prevent damage to the stoker from the oil fire. These specifications required the bidders to state a definite guarantee of boiler and furnace efficiency, which was to be demonstrated by a 24-hour continuous boiler test, in accordance with the code of the American Society of Mechanical Engineers.

In order to obtain the true value of fuel oil as compared to coal and to place all types of oil burners on the same basis such as those using mechanical steam and air atomizers, the net boiler and furnace efficiency was required, or the efficiency after deducting the steam required for atomization, for pumping oil to burners and for heating the oil above 80 deg. F., also the steam equivalent required to operate the fans if forced draft was required.

The specifications further stated that the test was to follow a variable load curve representing, as closely as possible, the actual steam-load requirements of the depot, and for this purpose a load was established and set forth in the specifications varying from a day load of 150 per cent of builders' rating to a night load of 50 per cent and back to a day load of 150 per cent. The specifications provided for liquidated damages of $900 for each one per cent that the successful bidder fell below his guaranteed net efficiency.

Six bids were received, one on mechanical burner and five on steam atomizing burners, with guarantees varying from 75 to 80 per cent net efficiency and with prices ranging from 30 to 80 cents per sq.ft. of boiler-heating surface.

The bid of the B. P. Lientz Co. was accepted as being the lowest, with a guaranteed net efficiency of 79½ per cent.

The contract was awarded Oct. 31, 1922, and the installation under the first boiler was completed Nov. 9, but the installation of the temporary service tanks, pumps and piping was not completed before Nov. 22, at which time an oil fire was started under one boiler. Immediately after the acceptance test, on Dec. 14, the other two boilers were placed in service and the conversion from coal to oil was completed.

Official Acceptance Test

The official acceptance test was run on Tuesday and Wednesday, Dec. 12 and 13, in accordance with the specifications, a small boiler provided for generating steam to be used for heating, pumping and atomizing the oil, and all water and oil weighed in tanks resting on platform scales. All other piping excepting the steam main was disconnected from the boiler or means provided to insure isolation from other piping. An

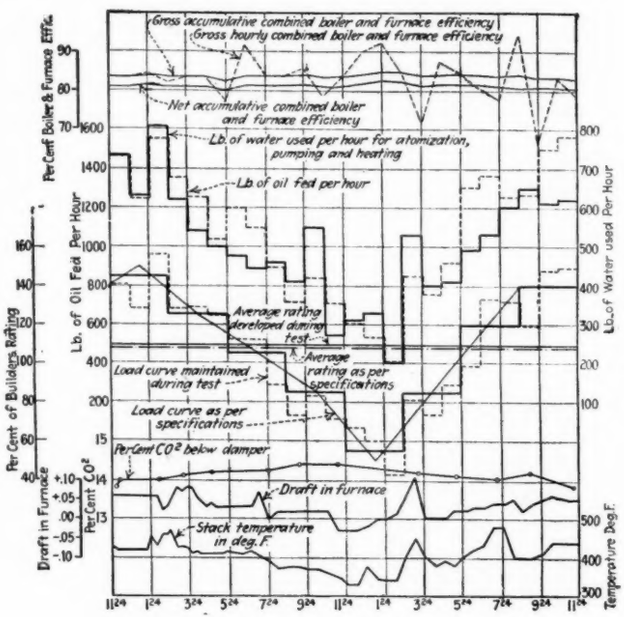

Gross accumulative combined boiler and furnace efficiency
Gross hourly combined boiler and furnace efficiency
Net accumulative combined boiler and furnace efficiency
Lb. of water used per hour for atomization, pumping and heating
Lb. of oil fed per hour
Average rating developed during test
Average rating as per specifications
Load curve maintained during test
Load curve as per specifications
Per Cent CO2 below damper
Draft in furnace
Stack temperature in deg. F.
Per Cent Boiler & Furnace Effic.
Lb. of Oil Fed Per Hour
Per Cent of Builders Rating
Per Cent CO2
Draft in Furnace
Lb. of Water used Per Hour
Temperature Deg. F.

FIG. 3—SHOWS GRAPHICALLY RESULTS OF 24-HOUR TEST

evaporating and separating calorimeter was used for determining the quality of the steam, an electric pyrometer for gas temperature and a hand Orsat for gas analysis, all in accordance with the test code of the American Society of Mechanical Engineers.

Present at the test in addition to the contractor were representatives from the Depot, the Quartermaster General's Office and from the Bureau of Standards, who observed the data independently.

The test began at 11:24 a.m. and terminated 11:24 a.m. the following day, a continuous 24-hour period.

There were two external mixing burners in each boiler, and they were not removed for cleaning or for any other purpose whatsoever for three hours prior to nor during the 24 hours of the test, at the end of which time they were taken out and officially inspected and found free from carbon.

The oil fired was Bunker C fuel oil, 14 deg. Baumé carrying 18,350 B.t.u. per pound.

The chart, Fig. 3, shows graphically the observed and calculated results, and a tabulation of the results and heat balance is given in the table, the salient features of the test being: (1) Exceptionally low draft required; (2) an economically low flue-gas exit temperature; (3) a high gross and net boiler and furnace efficiency well sustained over a wide range of operation.

The construction of the American oil furnaces installed in these boilers over the stokers is such as to preheat the air for combustion above the ignition temperature and to introduce this high-temperature air into the fuel-oil zone under a special tile arch. The steam atomizing jet produces a syphonic action assisting the draft to such an extent that a balanced or even a slight pressure condition is obtained in the firebox, so desirable in maintaining a high furnace temperature at low loads.

The flue-gas temperature varied from 330 deg. F. at the low loads to 440 deg. F. at the peaks. At the low load it was below that of the steam temperature in the rear upper row of tubes, these becoming in fact an economizer.

TABULATION OF TEST RESULTS AND HEAT BALANCE

1.	Total heating surface		4,400 sq.ft.
2.	Date		Dec. 12-13, 1922
3.	Duration		24 hours
4.	Kind of fuel		Bunker C Fuel Oil
5.	Steam pressure by gage, lb. per sq.in.		124.6
6.	Barometric pressure, in.		30.14
7.	Absolute pressure, lb.		14.80
8.	Absolute steam pressure		139.37
9.	Quality of steam, per cent		98
10.	Average feedwater temp., deg. F.		157.98
11.	Average gage pressure of oil at burners, lb.		33.46
12.	Average temperature of oil in weighing barrel, deg. F.		85.7
13.	Average stack temp. in degrees F.		409.57
14.	Average CO_2		14.09
15.	Average O_2		1.91
16.	Average CO		None
17.	Average draft in furnace, inches of water		0.019
18.	Average boiler from temp., deg. F.		50.6
19.	Oil fed for 24 hours, lb.		25,274.5
20.	Total water fed for 24 hr., lb.		367,294
21.	Factor of evaporation, corrected for moisture		1.0809
22.	Equivalent evaporation, total, lb.		497,008
23.	Equivalent evaporation per hour		16,542
24.	Rated evaporation per sq.ft. per hour, lb.		3.45
25.	Equivalent evaporation per sq.ft. per hour, lb.		3.72
26.	Average rating required by specification, per cent		108.
27.	Percentage of rating developed		108.9
28.	Actual evaporation per pound of oil		14.53
29.	Equivalent evaporation per lb. of oil		15.7078
30.	Calorific value of fuel		18,350
31.	Gross efficiency of boiler a...furnace, per cent		83.067
32.	Pounds of water required for atomization, pumping and heating during 24 hours		11,209
33.	Pounds in per cent of total water evaporated in 24 hours		3.051
34.	Actual evaporation net in 24 hours		356,085
35.	Equivalent evaporation net in 24 hours, lb.		384,892
36.	Equivalent evaporation net per lb. of oil		15.228
37.	Net combined boiler and furnace efficiency		80.53
38.	Ultimate analysis of oil (Bureau of Mines)	Per Cent	
	(a) Carbon	83.21	
	(b) Hydrogen	11.05	
	(c) Sulphur	4.01	
	(d) Oxygen and nitrogen	1.73	
		100.00	

39.	Heat Balance		B.t.u.	Per Cent
	(a)	Heat absorbed by boiler	15,242.84	83.067
	(b)	Loss due to heat, carried away by steam formed by the burning of hydrogen	1,211.78	6.603
	(c)	Loss due to heat, carried away in the dry chimney gases	1,285.51	7.005
	(d)	Loss due to carbon monoxide	0.	0.
	(e)	Loss due to heating steam used for atomizing	16.58	0.087
	(f)	Loss due to unconsumed hydrogen and hydrocarbons, to radiation and unaccounted for	592.29	3.238
			18,351.00	100.000

The average steam required for pumping, heating and atomizing the oil was approximately 3 per cent of the total steam generated by the test boiler, or about 0.44 lb. per pound of oil atomized.

The gross boiler and furnace efficiency with a 2 per cent moisture correction averaged 83.067 per cent with fuel oil of 18,350 B.t.u. per pound and the average net boiler and furnace efficiency was 80.53 per cent, indicating that the contractor had exceeded his guarantee of 79.25 per cent by slightly over 1.25 per cent.

We believe these results, obtained over a variable load curve for a period of 24 hours, observed in an official manner and obtained by scale weight measurements, represent a high record of gross and net combined boiler and furnace efficiency.

The Pressure Problem of Oil-Engine Pumps

By H. F. Shepherd

The advent of solid-injection engines with plain Diesel-type combustion chambers brings up the problem of pumps and spray nozzles. These have been used in the semi-Diesel engine for years, but it appears that injection systems that sufficed for the older type of engines require further development for adaption to the newer type of solid injection.

Among engineers the statement that liquids are practically incompressible has been accepted as one based on facts. The philosopher who propagated this misleading and altogether too easily remembered statement goes free on the qualifying word "practically." While it is safe to assume that liquids are inelastic for all ordinary pumps, the solid-injection oil engine introduces a pumping problem of such refinement that the statement is not borne out by facts.

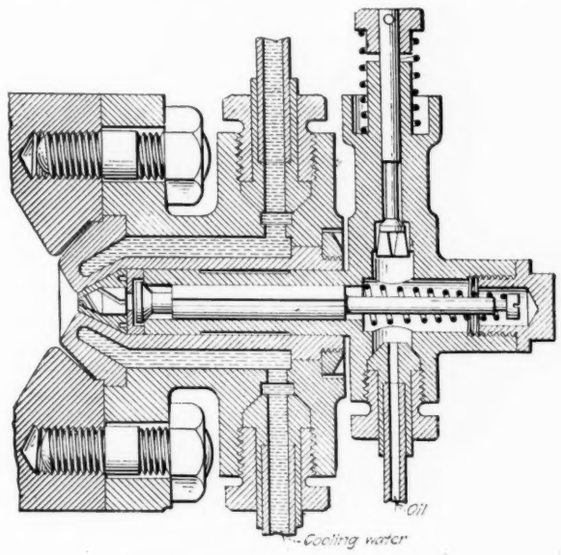


FIG. 1—TYPICAL OIL PUMP

The Smithsonian Physical Tables and Kaye and Laby's Physical Tables quote the same value for the compressibility of liquids, with Martini as the authority. If V_1 is the volume under pressure p_1 atmospheres at t deg. C. and V_2 is the volume at p_2 and the same temperature, then the compressibility coefficient may be defined at that temperature as

$$B_t = \frac{1}{V_1} \times \frac{V_1 - V_2}{p_2 - p_1}$$

For petroleum but one value is given, no pressure being stated. This is $B \times 10^6 = 70$ when $t = 16.5$ deg. C.

Some day the Smithsonian Institution or the Bureau of Standards may provide accurate tables of the performance of petroleum products under various pressures and temperatures. Until that time, as the measurements are too delicate for the resources of the mere engineering shop and technical force, one must be content with the assumption that $B_t \times 10^6 = 70$ for the range of pressure that is employed in oil-engine work.

Taking a pressure of 4,500 lb. or 300 atmospheres, as an ordinary value for modern engines, the fluid be-

tween the pump suction valve and spray tip will be compressed in action $\frac{70 \times 300}{1{,}000{,}000} = \frac{21}{1{,}000}$ of its volume.

On this basis, if the volume of oil contained between the pump suction valve and the spray tip equals $\frac{1{,}000}{21}$ = 48 times the pump displacement, the compressibility of the oil will absorb the movement or displacement of the pump plunger.

As fuel charges of 0.05 to 0.1 cu.in. are commonly required for engines ranging from 50 to 100 b.hp. per cylinder, volumes of 0.05 × 48 = 2.4 cu.in. to 0.1 × 48 = 4.8 cu.in. of oil beyond the suction valve will

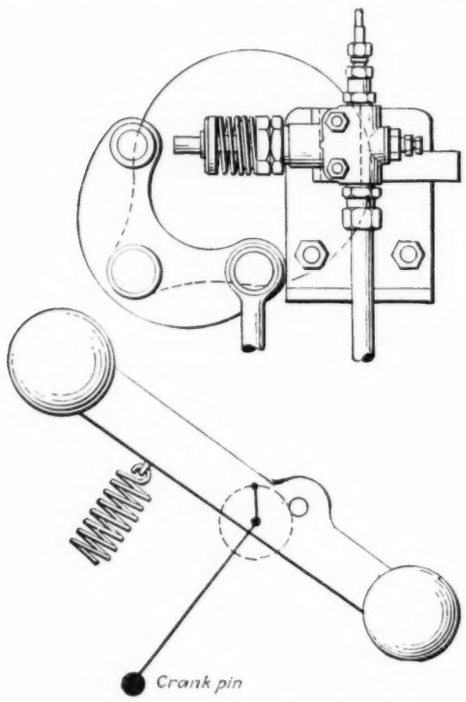


FIG. 2—PUMP WITHOUT BY-PASS

result in compressibility equal to the required pump delivery. Then with the best design one must expect and dispose of, or turn to good use, a considerable elasticity effect in the fuel oil, regardless of how well the pumps and piping have been designed.

This leads directly to the consideration of the spray nozzle itself. It is impossible to eliminate entirely the clearances between the pump suction valve and spray nozzle. In employing a spray nozzle such as shown in Fig. 1, a high spring tension on the check valve should not be applied, for the resistance of the check adds to the resistance of the delivery orifice, thereby increasing the pump pressure to no good advantage.

If a spray is connected to one of the old variable stroke pumps operated perhaps by a shaft governor, as in Fig. 2, and with no means of relieving the pressure on the spray side of the discharge valve after each injection, discharge will start almost as soon as the pump picks up. It will continue at an increasing rate as long as the pump plunger moves, or at least at some forced rate depending on the mechanical movement of the pump plunger. After the pump plunger has reached the end of its stroke, the elasticity of the fuel beyond the discharge valve will cause a further slow discharge until the spring and cylinder pressures seat the check.

Obviously, that part of the discharge which takes place at the lower pressure levels will not be well atomized, and that part which takes place after the plunger motion has ceased will lengthen out the injection period beyond what is suitable for good operation. To avoid this action, pumps are fitted with a governor-operated bypass to bleed down the injector pipe pressure at the cessation of forced injection as at *C* in Fig. 3. The inertia of the column of fuel and the impact of the pump probably help to start injection right even with the lightly loaded spray check in Fig. 1, and it may be said for sprays employing a centrifugal whirl that they probably atomize better at pressures below their true working pressure than do the multiple orifice sprays. Unfortunately, their cone of distribution is rather narrow for good working in Diesel-type combustion chambers.

The writer has on two different occasions conducted comparative experiments to determine whether it is necessary to employ a bypass on the injector pipe to relieve the pressure after each injection with spring-loaded sprays of the differential needle type shown as part of Fig. 3. On both occasions there was no measurable difference in economy with or without the bypass. It has always been our impression that engines are more prompt in governing and sprays less liable to internal carbonization or oxidation due to blow-back of gases of combustion, if the oil pressure is maintained on the injector pipe, therefore these tests.

This brings one to the design of the spray nozzle, which is seemingly far more important than the fuel pump, its clearance or the clearances, within the spray nozzle, or whether or not the bypass be employed to

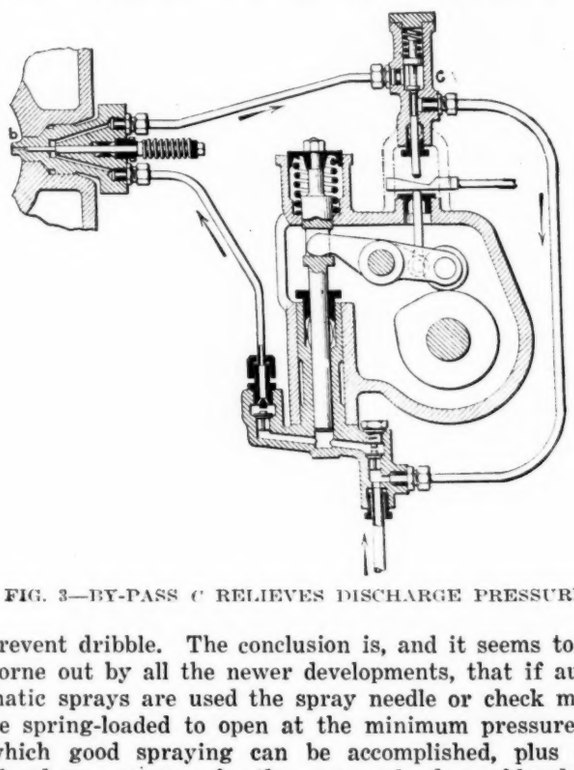


FIG. 3—BY-PASS *C* RELIEVES DISCHARGE PRESSURE

prevent dribble. The conclusion is, and it seems to be borne out by all the newer developments, that if automatic sprays are used the spray needle or check must be spring-loaded to open at the minimum pressure at which good spraying can be accomplished, plus the blowdown pressure, for the spray valve has a blowdown characteristic just exactly as a safety valve has that characteristic and must be carefully designed on the same principles as a good modern safety valve.

Reconnecting Direct-Current Machines—Changes in Voltage—III

Changing the Winding on a 50-Kilowatt 125-Volt Generator with Equalizer Connections on the Commutator to Produce 250 Volts—How to Change a 250-Volt Generator to Operate at 32 Volts

BY A. C. ROE*

MEDIUM and large-sized armatures are frequently arranged with equalizing connections, but this does not involve any additional complications. For example, a 50-kw. 125-volt shunt-wound 8-pole generator, which operates at 550 r.p.m. is to be reconnected for 250 volts. The shunt coils have 610 turns of one No. 10 d.-c.-c. wire and the armature has 80 slots and 80 bars, lap winding, two coils per slot, each coil one turn of two $\frac{3}{16}$x$\frac{1}{2}$-in. copper strap in parallel, coil pitch 1 and 11 and the leads are connected to adjacent segments, on center line of coil, the armature is cross-connected, having 40 S-shaped straps at the back of the commutator, pitch of each strap 1 and 21, spaced 1 and 3 as in Fig. 1; this is 50 per cent complete equalization.

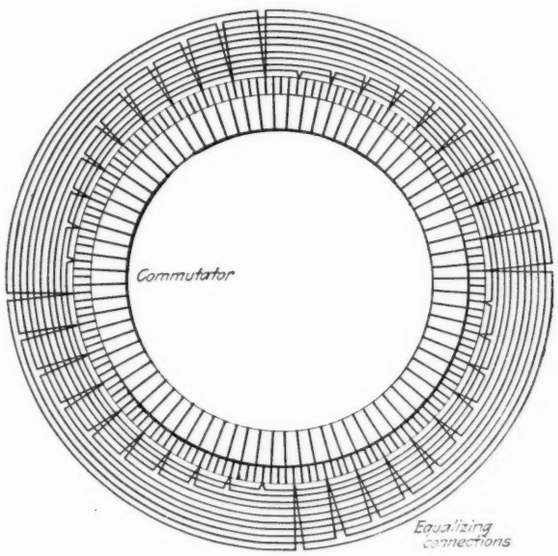


FIG. 1—EQUALIZING CONNECTIONS ON COMMUTATOR OF 8-POLE ARMATURE

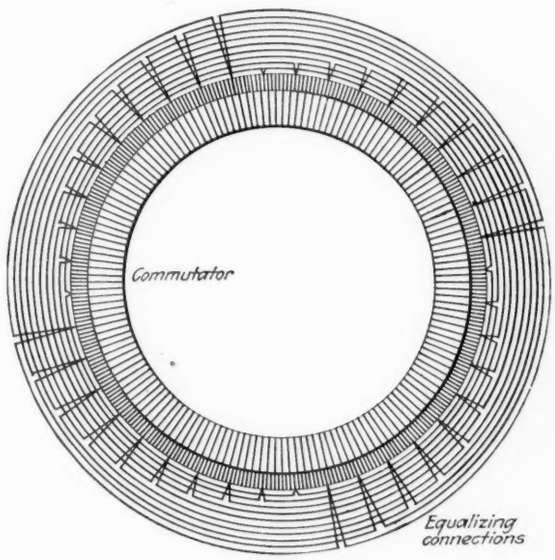


FIG. 2—SAME AS FIG. 1, EXCEPT COMMUTATOR HAS 160 SEGMENTS INSTEAD OF 80

Figuring the 250-volt winding, the shunt-field coils will have $(250 \div 125) \times 610 = 1{,}220$ turns. One No. 10 has an area of 10,380 circ. mils, then the new size wire equals $10{,}380 \div 2 = 5{,}190$ circ. mils. The nearest to this is No. 13 with an area of 5,178 circ. mils, which is satisfactory. Therefore the shunt coils will have 1,220 turns of one No. 13 double-cotton-covered wire.

The shunt coil for 125 volts had 21 layers wound, 15 layers of 30 turns per layer, 2 layers of 29 turns, 1 of 28, 1 of 27, 1 of 26, and 1 of 21 turns. The diameter of one No. 10 d.-c.-c. wire is 0.112 in.; then 30 turns equals 30×0.112, or 3.36 in. One No. 13 d.-c.-c. wire has a diameter of 0.081 in.; then turns of No. 13 in the space occupied by one 30-turn layer of No. 10 equals $3.36 \div 0.081 = 41$ turns. Twenty-one layers of No. 10 equals $21 \times 0.112 = 2.352$ in.; then the number of No. 13 wire layers equals $2.352 \div 0.081 = 29$ layers. Twenty-nine layers of 41 turns per layer equals $29 \times 41 = 1{,}189$ turns, which is $1{,}220 - 1{,}189 = 31$ turns short of the required number. This could be wound in on an extra layer thus making a total of 29 layers of 41 turns and one layer of 31 turns.

Consider the armature winding, which consists of 80 strap copper coils of two $\frac{3}{16}$x$\frac{1}{2}$-in. straps in parallel. The best method would be to get a new commutator with $2 \times 80 = 160$ bars and reinsulate the coils by separating the straps to make 160 one-turn coils of $\frac{3}{16}$x$\frac{1}{2}$-in. copper and connect the coils to form a single-lap winding as originally. In an 8-pole winding, with 80 coils and bars, there are $80 \div 8 = 10$ commutator bars between brushes, so that there are $125 \div 10 = 12.5$ volts per bar. With 160 coils and bars there will be $\frac{160}{8} = 20$ between brush groups and the voltage per bar is $250 \div 20 = 12.5$ volts as before.

The next item to consider is the equalizer connections on the commutator. If convenient the cross-section can remain the same or it can be reduced in the same proportion that the voltage is increased. Whenever the voltage of a machine having cross-connections is reduced, the cross-section of the connectors should be increased in the same proportion that the voltage is reduced. The

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most important thing is to keep the pitch and spacing of the connections correct.

With the 125-volt winding there were 40 cross-connectors, pitch 1 and 21. For the 250-volt winding and 160-bar commutator the forty old connectors can be used, as the angle included between the ends of each connector is the same; that is, 360 deg. divided by 4, or 90. The pitch will be $160 \div 4 = 40$ segments, or 1 and 41, and the spacing $160 \div 40 = 4$ bars, or 1 and 5, as in Fig. 2. With 160 bars and coils and 40 cross-connectors, the machine is $40 \div 160$, or 25 per cent equalized, which is sufficient. On an 8-pole machine the least number of connectors would be four rings with four taps to each ring, or a total of 16 taps in all, which would be $16 \div 160$, or 10 per cent equalization.

Changing 250-Volt Generator to 32 Volts

As another case, assume that it is desired to reduce the voltage of a 10-kw. 250-volt generator to 32 volts. Now 10 kw. equals 10,000 watts, and at 250 volts the amperes will be $10{,}000 \div 250 = 40$. For 32 volts and the same output the amperes will be $10{,}000 \div 32 = 312.5$. This will require a wider brush, one that will cover at least three bars, to enable the commutator to carry the extra current without overheating. If the brush section is still too small, a different grade of brush will have to be selected.

Another feature is that the armature turns will have to be decreased in the same proportion as the voltage, or new turns will be $250 \div 32 = 0.128$ of the number in the old winding. If there were four turns per coil in the old winding, the new turns would have $4 \times 0.128 = 0.512$, or $\frac{1}{2}$ turn. If the winding were single-wave or single-lap connected the equivalent of a half turn per coil could be obtained by using a one-turn coil and connecting the winding double wave or lap as the case might be. From this it is obvious that the old turns would have to be at least eight before a one-turn coil could be used with the same speed. If the new turns required came to a fraction, then the nearest whole turn would have to be used and the speed changed to suit. If the old turns were six per coil, the turns for the new coils would equal $6 \times 0.128 = 0.768$ turn. Then if a one-turn coil were used, the speed would have to be decreased to 0.768 of the original speed. If the original speed was 1,000 r.p.m., the new speed equals $1{,}000 \times 0.768 = 768$ r.p.m. If the machine was a motor and a one-turn coil used instead of the fractional 0.768 turn, the speed of the motor would drop to 768 r.p.m.

Cautions To Be Observed in Reducing Voltage

Whenever a large decrease in voltage is desired and the horsepower or kilowatt rating is to remain the same, a careful check should be made on all the current-carrying parts to determine whether each circuit has sufficient cross-section to carry the increased current. On some of the older types of machines the brushes are not provided with shunts so that the brush boxes and holders carry the current. In this case, if the current is increased, the brushes will have to be equipped with shunts, otherwise the brush rigging may heat. Other points that require checking are the width of the commutator bars and the number of bars covered by the brush with the original voltage rating. Then the same current density in the brush and bar should be preserved if possible with the lower voltage rating.

The changes cited in this and previous articles have all been worked out by proportion, using the old values as bases to find the new. Therefore, it follows that a few simple formulas and rules cover the full range of voltage changes, but the actual method of accomplishing the desired changes will vary with each machine.

The following data should be taken in each case: First, the old rating in horsepower or kilowatts, voltage, amperes, speed, type of armature winding, number of slots, number of bars, turns per single coil, size of wire, in connection with size of wire. State whether one, two or more wires are used in parallel per single coil; that is, say wire one No. 10, two No. 12, etc. Give weight of shunt coil or if possible turns per coil, size of wire in shunt coil, size of wire and turns per coil in the series and interpole coils, number of brush holders, brushes per stud, size of brushes. Put these down in tabular form, then take each item separately and calculate the new values.

Changes in the Armature

In reference to the armature bear in mind the following:

Changing from a single lap to a single-wave winding in a machine having 4 poles, the turns are doubled and the cross-sectional area of the copper is reduced $\frac{1}{2}$.

In a 6-pole machine the turns are increased 3 times and the cross-sectional area of the copper is reduced to $\frac{1}{3}$.

In an 8-pole machine the turns are increased 4 times and the cross-sectional area of the copper is reduced to $\frac{1}{4}$.

In a 10-pole machine the turns are increased 5 times and the cross-sectional area of the copper is reduced to $\frac{1}{5}$.

In a 12-pole machine the turns are increased 6 times and the cross-sectional area of the copper is reduced to $\frac{1}{6}$.

Changing from a single-wave to single lap winding, in a machine having 4 poles the turns are decreased to $\frac{1}{2}$ and the cross-sectional area of the copper is increased by 2.

In a 6-pole machine the turns are decreased to $\frac{1}{3}$ and the cross-sectional area of the copper is increased by 3.

In an 8-pole machine the turns are decreased to $\frac{1}{4}$ and the cross-sectional area of the copper is increased by 4.

In a 10-pole machine the turns are decreased to $\frac{1}{5}$ and the cross-sectional area of the copper is increased by 5.

In a 12-pole machine the turns are decreased to $\frac{1}{6}$ and the cross-sectional area of the copper is increased by 6.

In the armature circuit a variation in either direction in the turns or cross-section of copper of 3 to 7 per cent can be made in nine cases out of ten without any ill or noticeable effects. In the field circuit the shunt coils should have the same ampere turns, which means that the resistance of the shunt coils should be varied in the same proportion as the voltage and in the same direction. On interpole windings the turns must be kept to the required amount, but the cross-section of copper can be increased or decreased about 5 per cent without danger of getting into serious difficulties. In every case it will be the armature circuit that will be the most troublesome, hence, close attention to this part of the change will help to make this part of the reconnection a complete success.

Powdered Coal Installation, Whitaker-Glessner Plant, Wheeling Steel Corp.

DURING 1921 the Wheeling Steel Corporation laid plans for a new boiler plant at its Whitaker-Glessner Works, Wheeling, West Virginia. The original plans called for water-tube boilers and underfeed stokers and the plant was designed for this equipment. However, before the plant was completed it was decided to convert two boilers to powdered coal. As the boiler settings had been designed for stokers and

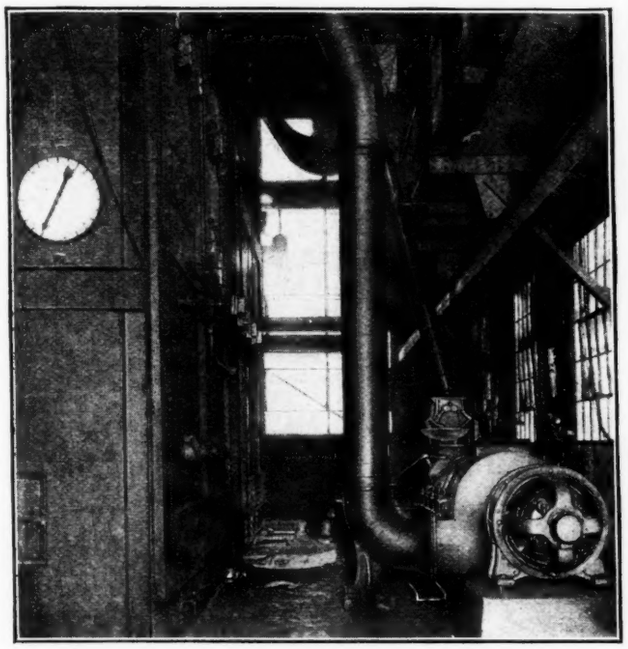


FIG. 1—GENERAL VIEW OF BOILER ROOM, WITH PULVERIZER LOCATED IN FRONT OF BOILER

the steel work was already in, the design of the combustion chamber was necessarily a compromise with local conditions. It was finally decided to equip the first boiler without making any extensive alterations to the design of the original setting.

Fig. 1 shows the water-tube boilers each having 8290 sq.ft. of heating surface, and pulverized firing equipment as seen from the north end of the boiler house. The furnaces are extended in front several feet to give additional combustion space, as shown in the section Fig. 2. The arch forming the top of the combustion chamber, is of a special design with a series-circulation system of either water or air through the tile which is designed to control the temperature of the refractories. This arch is patented by executives of the Wheeling Steel Corporation and is now in successful use in several of their plants. Longer life for the arch is attained by the use of this air or water cooling system and the use of higher furnace temperatures with less excess air is permitted.

The pulverizing equipment shown in Fig. 1 is a size "G" steel-frame machine, manufactured by the Aero Pulverizer Co. of 165 Broadway, New York City. Another view of the machine is shown in Fig. 3. It consists of a rotor with five disks equipped with manganese steel paddles. The pulverizing is accomplished by the contact of coal in five separate compartments within the mill. The coal in contact with the revolving paddles is traveling at higher velocity than that thrown by centrifugal force toward the periphery of the compartment. It is claimed that this speed differential causes the contact of particle on particle and thus effects the pulverization. There is no contact between metal pulverizing parts of the mill.

The particles reduced in one chamber to the determined size are carried by air to the succeeding compartment of larger diameter for finer pulverizing which is accomplished by like action. The pulverized coal with air regulated at the will of the operator, is ejected from the machine by the fan. By adjusting the openings on the fan inlet manually or automatically any desired mixture of coal and air can be obtained and the flame in the combustion chamber may be made reducing, neutral or oxidizing as desired. By variation in the opening of the air inlet at the coal feed-table *T* a wide range of fineness may be obtained. The pulverizer is driven by 230-volt variable-speed motor with a speed range from 1200 to 1500 r.p.m., as the degree of fineness of pulverization is a function of the speed as well as of the quantity of entering air. The machine is provided with a pocket in the first pass for catching tramp iron. The coarse coal is fed into the machine

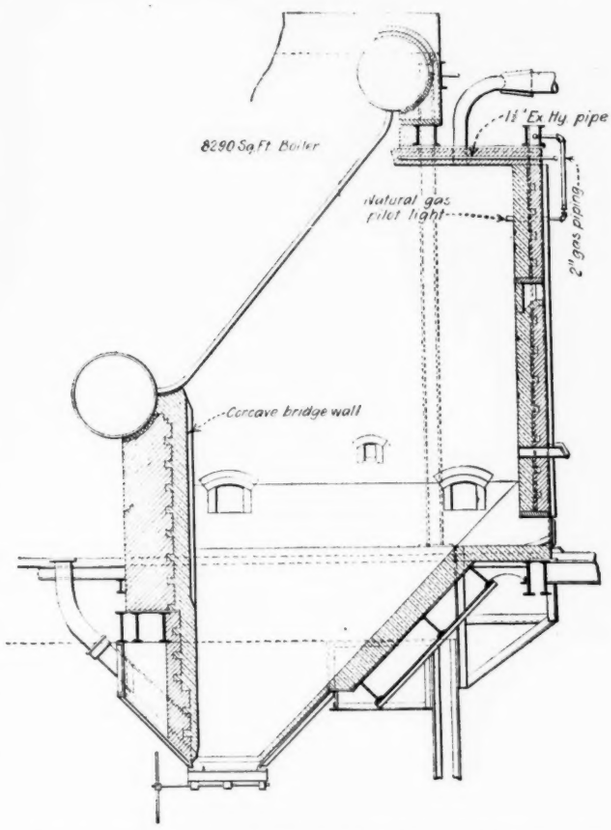


FIG. 2—SECTION OF BOILER SETTING. BURNERS ARE LOCATED IN FLAT ARCH AT TOP OF COMBUSTION CHAMBER

undried, and up to 5 per cent surface moisture, there is said to be no appreciable increase in power consumption. The power consumption in this type of pulverizer depends on the physical characteristics of the coal, such as friability, structure and percentage of ash. The average power consumption varies with the kind of coal over a range of from 14 to 22 kw.-hr. per ton.

Pulverized coal together with the greater part of the primary air is blown from the machine through a

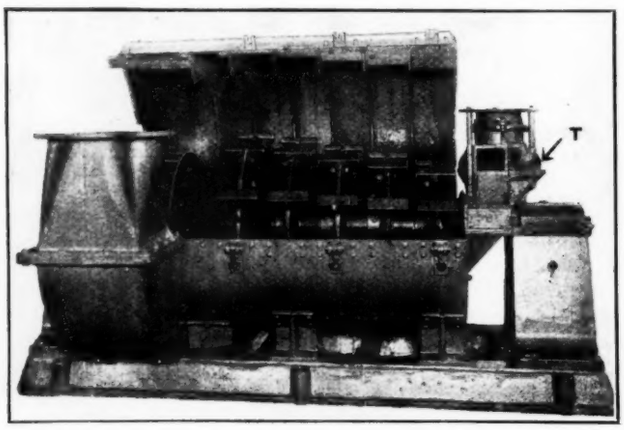


FIG. 3—VIEW OF PULVERIZER WITH COVER OPEN

transport pipe about 25 ft. upward and drops into a spreader with four openings through the arch into the combustion chamber of the boiler (see Figs. 1 and 2). The spreader is so designed that the two middle burners each take 30 per cent of the pulverized coal and the two outside burners each take 20 per cent of the fuel. The burners are essentially projections of the pipes leading from the spreader the size of which is varied to meet individual requirements. They are of the aspirating type in which air is admitted around the burner where it passes through the arch, the degree of opening being subject to manual or automatic control. A test made with a radiation pyrometer showed that the temperature along the side wall was 100 deg. less than the temperature in the middle of the furnace. This temperature difference is no doubt due to the fact that there is practically 10 per cent less coal fed at the side of the furnace than in the center, a condition which is conducive to preservation of the refractories.

Referring to Fig. 2, it will be seen that the setting is a solid wall with no hollow spaces for the purpose of preheating air or the preservation of the refractories. The slope from the floor line to the ash gate is the original slope intended for stoker firing and in the next installation, now under way, this is done away with.

There are no special openings in the side wall of this furnace except the usual inspection doors that are customary with a stoker installation. In the front wall there are four peep holes made of 4-in. pipe placed at eye level so that the boiler room operator can occasionally lift the cover of one of these holes and observe the condition of the furnace. When starting up a boiler the fuel is ignited by natural gas pilot lights installed in the front wall of boilers. These lights are first ignited by automobile spark gap ignition coils on the boiler front.

The boiler has an automatic combustion control which is connected to the feed table motor of the pulverizer, the air inlets of the pulverizer fan, the louvres on the 10x10-in. openings on the upper boiler front (see Fig. 1) and to the stack damper. These are regulated from the master control and all but the stack damper operates in response to fluctuations in the steam pressure. The stack damper is operated by variations in the furnace pressure.

The dial shown on the boiler wall in Fig. 1 is connected to a rheostat on the feed table so as to show the amount of coal being fed to the pulverizer.

RESULTS OF TESTS ON POWDERED COAL FIRED CONNELLY BOILERS

Date of test (1922)	Aug. 22nd
Fuel burning equipment	Aero Pulverizer
Heat Balance in Per Cent	
Loss due to moisture in coal	.22
Loss due to burning of hydrogen	4.13
Loss due to moisture in air	.25
Loss due to heat in dry flue gases	9.30
Loss due to radiation (assumed)	5.00
Total loss in heat	18.90
Efficiency of boiler	81.10
The heat balance was calculated on the basis of coal analysis as submitted by the Pittsburgh Testing Laboratory, which are given below (ultimate analysis of coal percentage by weight):	
Hydrogen	4.74
Carbon	68.08
Nitrogen	1.33
Oxygen	7.07
Sulphur	4.87
Ash	13.91
B.t.u. per lb. dry coal	12,647
The average of the principal results obtained during the tests is as follows:	
Total water evaporated for 24 hr., lb.	1,108,756
Total coal used for 24 hr., lb.	105,352
Equivalent evaporation from and at 212 deg. per lb. coal lb.	11.2
Boiler efficiency corresponding, per cent	86.1
Average rating developed during test period of 24 hr., per cent	172
Flue gas analysis, per cent by volume:	
CO_2	14.4
O_2	4.0
N_2	81.6
Temperature of feed water, deg. F.	208
Temperature of flue gas leaving boiler, deg. F.	470
Room temperature, deg. F.	77
Average steam press., lb. gage	190
Average superheat, deg. F.	27
Moisture in coal, per cent	2.08

An alarm bell is connected with the CO_2 recorder so that when the CO_2 drops below 13 per cent warning can be given to the boiler room operatives and the cause of the drop in efficiency can be determined and corrected.

After this boiler had been in operation a short time, a test was decided upon, and H. C. Siebert, fuel engineer of the Bethlehem Steel Co. was secured to take

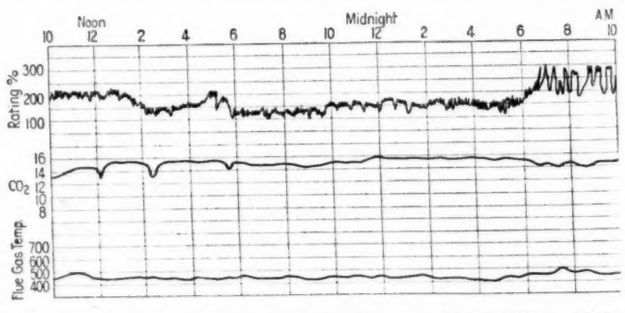


FIG. 4—PER CENT OF RATING AND CO_2 OBTAINED, ALSO FLUE GAS TEMPERATURE DURING 24 HOUR TEST

charge of the test. It was not the idea to try out the boiler for capacity or highest efficiency but to take conditions as they came, while carrying an ordinary steel mill load, or in other words with the plant operating under everyday conditions. The results of the test are given in the accompanying table and chart. Fig. 4 shows the average rating, CO_2, and the flue gas temperatures.

EDITORIALS

F. R. LOW, EDITOR

The High-Pressure Steam Accumulator

LEAVING out of consideration for the moment the all-important question of first cost, any piece of equipment capable of storing up energy and releasing it as desired has broad possibilities for usefulness in the power field. The storage battery, the flywheel and the water-storage areas of hydraulic power plants fall in this class. To these must be added the steam accumulator, which "stores" up steam in a mass of hot water, so there are at hand mechanically practicable means of storing electrical, mechanical and thermal energy.

Any of these forms of energy storage can, theoretically at least, be used to adjust a constant energy supply to a variable demand, a variable supply to a constant demand, or a variable supply to a variable demand (where variations in supply and demand do not synchronize). The cost of energy storage in any of these forms is largely that of the investment charge, which is generally high enough to restrict the applications to a narrow field. The flywheel, with its high cost per unit of energy stored, is commercially suited only for momentary fluctuations. At the other extreme lies water storage, which, in certain locations, may store energy from one season to the next.

The saving by energy storage may occur, not alone in reduced cost of the rest of the plant required to supply a given service, but also in an actual saving of energy that would otherwise go to waste (for example, in hydraulic power plants and in plants generating byproduct power from process steam). Still a third possible form of saving by energy storage comes from the higher thermal and mechanical efficiency of boilers, turbines, hydraulic turbines, etc., of smaller size operating at a higher load factor. To sum up, energy storage may produce a saving in the following three ways: Reduced investment cost in the rest of the plant, saving of energy that would otherwise go to waste and increased efficiency of power generation.

The high-pressure steam accumulator, whose operation and applications are the subject of an article in this issue, may be used to attain any or all of these objects. Since the amount of steam that can be stored in hot water depends upon the allowable variation in temperature (and hence in pressure) the accumulator cannot be commercially considered except where a large pressure variation is possible. This practically eliminates its use as a magnified steam and water drum connected to the high-pressure supply lines of prime movers. There remain many possible applications in plants using process steam at moderate pressures with or without the generation of byproduct power. Some of these are described in the article referred to. Most of the existing installations are in Europe, and these largely in the paper industry. It remains to be seen whether American power economics will permit of similar applications here.

The method outlined for approximating the necessary accumulator weight for a given application will enable engineers to arrive at a rough estimate of the cost of steam storage. If this indicates the possibility of a net saving, actual quotations may be obtained for a more accurate analysis.

One important limitation of the steam accumulator—the explosion hazard—is not mentioned in the article. Storing an enormous mass of hot water at pressures ranging up to one hundred pounds or more, the steam accumulator might well be compared to a "TNT" bomb. If it ever let go, the damage wrought would make an ordinary boiler explosion sink into insignificance. On the other hand, assuming proper design and reasonable precautions, the possibility of an explosion seems remote because of the absence of scale and firing strains. Without further experience it is impossible to say whether the remoteness of the possibility outweighs the greatly increased seriousness of an explosion, but this hazard must be kept in mind when estimating the net savings obtainable by this method of energy storage.

Better Methods of Checking Hydro-Electric Plant Operation

A STEAM-ELECTRIC power plant can be operated with no other instruments than a pressure gage, voltmeter and ammeter; likewise, in a hydro-electric plant, operation can be carried on with the same trio; but in either case high efficiency cannot be maintained under these conditions. In the steam station it was only when devices came into use that would give an intelligent indication of what the plant was doing that it was possible to maintain high efficiency. Today, in the modern steam plant the coal is weighed to each boiler, feed water and steam are measured, draft pressure is indicated, flue gas analyses and temperatures are recorded, automatic devices are provided to adjust the supply of air and fuel according to the load, and other refinements are available, so that at all times the operator may know what the boiler plant is doing. Careful checks can be made on the efficiency of each unit and any deviations from best practice detected and remedied. What is true of the boiler plant is also true of the other parts of the station, so that the modern steam plant is practically run under test conditions. This is not an engineering fad, but is sound economically, and results in producing a kilowatt-hour at the switchboard at a minimum cost.

In the hydro-electric plant, with few exceptions no such attention is given to maintaining high operating efficiency as in steam plants. It is true that some plants are operating with an excess of water and do not have to bother about efficiency. Such plants are rapidly on the decrease and many water-power plants are now operating in parallel with steam plants. In these stations it is just as important that the water be used at the highest efficiency as it is that coal be burned most economically in the steam plants. Lack of efficient methods in either results in an increased coal consumption to produce a given power output.

Methods of measuring the quantities of coal and water in a steam plant are fairly well standardized, and those methods that are applicable to one plant can be used in another. In the hydro-electric plant no such standardization exists. With medium- and high-head plants a venturi tube or the pressure differential of some part of the penstock, where there is a change in section, may be used to operate an indicator or recorder to give the water flow to the turbine. In the low-head plant no such simple method has yet been evolved.

One of the most common methods of measuring water to hydraulic turbines, where an attempt is made to obtain a record of flow, is by the use of rating curves giving discharge for various outputs and heads, these being based on tests made on the units or on test models. At best this method shows the most efficient point to operate at under various conditions of head and load when the unit was tested. It does not show any change in efficiency due to wear or breakage of various parts of the turbine or obstructions lodging against the gates. In some plants the turbine itself is made to act as a meter by using rating curves based on gate opening. However, unless apparatus is available for obtaining a weighted average of the gate openings, the results obtained by this method may be misleading, except where the turbine can be operated under continuous load long enough to make a check on its operation.

Little further gain in efficiency can be expected in hydro-electric units beyond what is possible at the present time. In the operation of these units much can be done, but this will require better and more accurate methods of water and head measurements than are available in most plants. A cubic foot of water at a hydro-electric plant has a definite value, just as a pound of coal has at a steam plant, and there is no economic law that justifies the waste of either.

Effect of Miners' Demands on Cost of Coal

THE latest turn in the negotiations between anthracite operators and miners creates a situation in which public opinion is likely to be called upon to place the responsibility. It is therefore important that the public know to what extent acquiescence in the miners' demands would affect the cost of coal.

Of the eleven demands those that are likely to enter appreciably into the production cost are: That the contract wage scale be raised twenty per cent and that day labor receive an increase of two dollars per day. The demand for a general eight hour day, with consequent readjustment of rates for those affected, would involve only a very small percentage of the workers, who are not already on an eight-hour basis; hence would not greatly influence the cost of mining. Increased rates for diversified labor around the mines, such as carpenters, pump men, etc., would add slightly to production costs, but to what extent it is difficult to figure. The remaining demands largely concern relations between the operators and the union and are of little interest to the public. They should be susceptible to compromise and need not form the basis of a deadlock in the negotiations.

The average daily wage of the mine workers is about $5.90 (ranging from the outside laborers at $4.50 to the contract miners who receive close to $8). Barring strikes, the miners have worked in the last few years around 270 days a year. The increases asked for would average about $1.90 per day per man. Inasmuch as the output per worker (all labor considered) is slightly under two tons per day, this would add approximately one dollar to the cost of each ton of coal mined. But as the steam sizes are in competition with bituminous coal, to raise their prices materially would render them practically unmarketable. Therefore, the operators contend that the whole burden of the increase should be borne by the domestic sizes for which the demand now far exceeds the supply. Domestic sizes form sixty per cent of the total anthracite tonnage mined. Consequently, they would have to bear an increase of over $1.50 per ton. This would likely be further augmented by higher royalties and greater margin for the producer, jobber and retailer.

By insisting on further wage increases, the miners are seeking an advantage over their fellow workers in other industries, who of necessity must have coal, and at a time when there is a general feeling against further inflation, especially in any commodity.

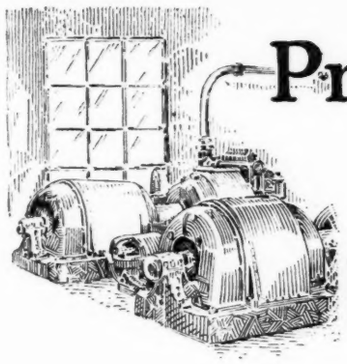
Publication of the Federal Coal Commission's report on anthracite several weeks ago laid bare some of the factors responsible for the present high prices of coal, such as excessive royalties, high freight rates, resulting in large surpluses on certain railroads controlling the coal mines, and speculative juggling by the jobbers. It is imperative that these abuses be corrected; in fact, the Interstate Commerce Commission has already begun an investigation of the freight rates on coal.

In view of the foregoing, the miners' demands come at a most inopportune time inasmuch as they will tend to divert attention from these abuses and alienate public sympathy from the miners to the operators.

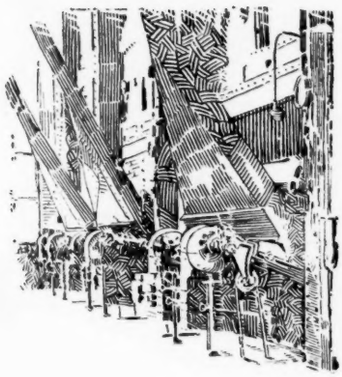
Just what measures the government is prepared ultimately to pursue in the event of a strike, are problematical at this writing. To take over the mines as an emergency measure, would confront the government with the alternative of meeting the miners' demands, and thus putting the burden of cost on the consumer, or breaking the strike through importation of labor into the coal fields—a difficult problem when labor is scarce, unless the immigration bars were to be let down temporarily. It is apparent that for the present an attempt will be made to handle the situation on economic grounds by encouraging the use of bituminous and other substitutes and by regulating the distribution through the Federal Fuel Distributor and various state agencies.

Many who have made a close study of the problem are of the opinion that permanent relief will come only when bituminous coal and other substitutes have become so general for domestic use in the East as to set up real competition with anthracite, and when an agreement between operators and miners has been effected to extend over a long period. With the demand thus lessened, the operators would work only the thicker seams at a considerably reduced labor cost per ton and the speculative element caused by periodic coal shortage would be removed. Attention could then be directed to eliminating some of the conditions brought out by the Federal Coal Commission's report and there would be prospect for reduced rather than increased coal prices.

Fortunately many consumers have profited by their experiences of the last three or four years and have already laid in coal to the extent of nearly twenty-five million tons, according to official estimates. This will simplify the problem to some extent.



Practical Ideas *from* Practical Men



Making Joints to Withstand Steam and Hot Water

The increasing use of high pressure and superheated steam in engines makes it necessary to exercise more care in making the joints between the cylinder head and steam-chest covers. In my opinion the best form of joint, whether it is used for high or for low pressures, is the ground joint, and the next best one is obtained by scraping. To make a fine ground joint between a cylinder-head cover and the cylinder of an engine, proceed as follows: Give one surface a thin coating of red lead and after it is evenly distributed, rub the two surfaces together. Then take off the cover and look for high places, removing them with a scraper. The parts should be rubbed together again a few times, and then examined. If they are marked in several places, it indicates that they are nearly true.

It is quite important that the rubbing be carefully done, an even pressure being used in revolving one surface upon a similar one, because they are liable to cut each other if the pressure is uneven; the presence of any grit causes them to cut. Should the cutting once begin, the accumulated metal increases the abrasion with the result that a groove, once cut, will get deeper until a complete revolution has taken place. This applies to all revolving surfaces but more especially to conical or radial ones. The tendency to cut can be overcome by making the movement partly reciprocating, which prevents any grit from becoming embedded in the iron and works it out.

Wipe both surfaces clean and then pour on a small amount of oil, next put on some dry emery, using No. 60 grade for a surface of about 15 in. in diameter or over, and No. 70 for smaller diameters. The oil and emery mixture ought to be applied to the parts to be ground and the rotary movements continued until the ground parts move smoothly, which shows that the emery and oil have done their work properly. Next remove the cover and examine the faces of the metal for bright spots, which denote that the abrasive has not touched them. If the surfaces are wiped clean of all oil and emery, the difference between the spots that have been affected by the rubbing and those that have not will be more readily seen; for those parts that have not been in contact with the abrasive will remain bright, while the others will have a dull and frosted appearance. The grinding operation must be continued with the same grade of emery until the entire surfaces of both parts of the metal appear evenly ground.

The second rubbing operation should be done as follows: Wipe both faces clean and apply oil and emery in the manner previously described, but use a finer grade of emery; No. 80 or 90 will be about right. Move the part as before described until it revolves so smoothly that it shows that the emery has worked properly and is no longer grinding the surfaces. Next wipe off all oil and abrasive and put the parts together and revolve them a few times while in contact. Should a jarring sound be heard, wipe clean again or the surfaces will abrade and destroy the smoothness of the metal. If no jarring noise is heard, continue the operation of revolving the parts against each other until the faces have made five revolutions. Then take off the movable face and it will be found that the emery and oil that had worked into the surface of the metal, will have worked out. Then wipe both parts clean, put them together and repeat the rubbing as before.

Should the faces cling to each other, separate them and wipe all oil and any particles of emery that may remain. Do this about three times. When the faces of the metal become bright and clean, they will show the slightest defect in the joint. Before being made up, put a little oil on the metal to prevent rusting. In making a scraped joint, one of the two surfaces must have a coating of red lead put on it and be rubbed against the other so as to show the high spots. The cover ought to be moved to three or four different positions, and if the rubbing marks show in the same places, it indicates that the high spots are on the movable part or cover. If such marks show at different places on the metal, they are on the stationary section. A scraper and file or in some cases a chisel may be needed to help make the two surfaces fit. Fitting joints together by scraping is a long and tiresome job and requires considerable skill and judgment.

In cases of emergency repairs on breakdown jobs in which there is no time for making ground or scraped joints, and tight connections have to be made between rough or untrue surfaces, a copper-wire gauze joint will give good results if carefully made. First give the joint a coating of red-lead putty, evenly distributed; cut the wire gauze to proper size and put into position. Then put over the gauze a coat of red lead, place the cover on and screw the nuts up tightly. If some of the nuts are screwed up on one side in advance of the others, the red lead will be squeezed out and the joint will be likely to leak and give trouble.

For hot-water joints to stand high pressure and to be used soon after making, paper, pasteboard and duck are the best materials. To make a joint of this kind, provided that the flanges have good strength, cut one disk the full size of the flange and also one disk having its external diameter sufficiently large to fit inside of the holes. If the flanges are of a fair fit, one thickness will be sufficient; where the flanges are not faced up

properly, it may be necessary to use three, four or possibly five thicknesses. In a case of the latter one thickness should be placed inside of the bolt holes. When placing the disks in position, spread a thin coating of red lead on each one and also on the faces of the flanges, then tighten the bolts evenly all around. A mixture of litharge and glycerin will also make a good watertight joint, but it has the disadvantage of being difficult to take apart if it should be necessary. Litharge and glycerin mixture is excellent to use on the threads of gasoline pipe lines, as the fluid has no effect on it and leakage is prevented.

A good packing for rough joints can be made from four or five strands of hemp saturated with a mixture of white lead ground in linseed oil. This causes the fibers of the hemp to cling together. Next plait the strands of hemp and give it a good coating of red lead over all its surfaces. Then place the rope in position, taking care that all the lapped joints bear evenly so that the joint will be of equal thickness. In some cases a piece of copper wire is bent to the proper shape and then the hemp is wound around it.

Where joints have to withstand a great heat, it is best to use $\frac{1}{8}$ in. thick asbestos boards. This should be coated with red lead mixed with boiled linseed oil, and it should contain as much of the latter as it will absorb. For a cold-water joint which is not subjected to great variations of temperature, common sheet lead will make a good joint, but if there are great differences in temperature, the expansion of the pipe will soon cause the lead to squeeze out of position.

In emergency cases a soft-wire ring can oftentimes be used to advantage if found to lie within the diameter of the bolt holes and brazed together at the ends. Should the joint not be a true circle, the wire must lie in a groove or a shoulder made for it to butt against. This prevents it from being forced or blown out of place by the pressure. Excellent gaskets can also be made for high steam pressure out of soft sheet copper $\frac{1}{32}$ in. thick, put on the cylinder head of an engine when the latter is cold and screwed up tightly. The expansion of the copper, when hot, makes a very good joint. In emergency work, when no copper was handy, I have found out by experience that two sheets of zinc can be used as a gasket on a steam engine. In many cases rubber is used to make steam,- water- and air-tight joints. A drawback to the use of sheet rubber is that after it has been in use a short time the heat and pressure compress it, and if the nuts are not tightened up, the joint will leak. W. S. STANDIFORD.

Youngstown, Ohio.

Factors That Affect the Life of Iron Stacks

There are many thousand iron smokestacks in use throughout the country, and where the fuel contains sulphur, the stacks are usually short-lived, a source of worry and expense and cause interruption of operation while they are being replaced or repaired. Their first cost is low; that accounts for their use in most cases.

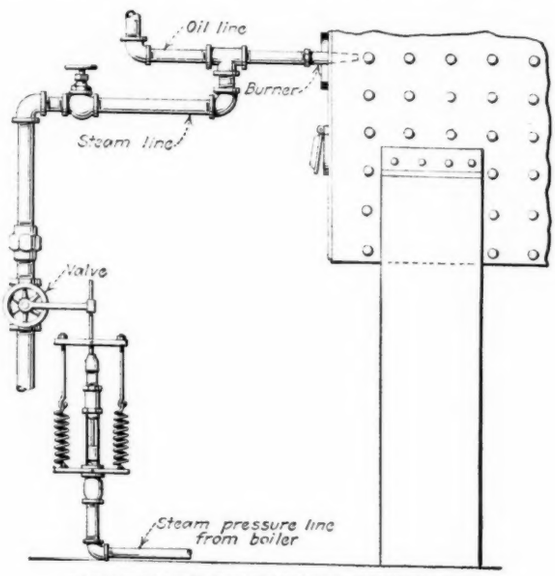
Where the sheets are $\frac{1}{8}$ in. or less, the rivets are driven cold and usually headed over on the inside mainly because the job looks better. I consider this poor practice because the head is flattened down until it is quite thin and is corroded by the sulphur more readily than the plates, and the plates soon become loose. With the head of a rivet on the inside a stack lasts much longer, owing to the greater amount of metal exposed to the corrosive action of the gases. Since the wasting of the plates always takes place at the seams, this would indicate that the air leakage through the joint makes the sulphurous fumes more active. No doubt it would pay well to use sheets thick enough to drive the rivets hot and then calk, thereby make an airtight joint.

It is always the upper part that gives trouble first, due to the greater condensation in this part of the stack. In our location the northwest side is usually wasted away first, doubtless because our cold winter winds come mostly from that direction. We have two stacks 50 in. in diameter and 90 ft. high. At one time they had to be renewed at about the same time, and to facilitate painting we had a ladder attached to one of them, but we made the mistake of attaching it directly to the stack without making any provision for expansion and contraction. A slip joint every twelve feet, I believe, is about right. Also, the stack with no ladder lasted nearly three years longer than the other. It has been my experience that such ladders soon become dangerous because their fastenings corrode away. Possibly other readers can suggest a way of increasing the life of iron stacks. J. O. BENEFIEL.

Anderson, Ind.

Oil-Burner Regulator

During a visit to the A. T. & S. F. Ry. shops at Kingman, Ariz., I ran across an automatic oil-burner regulator that had been made by the plant engineer. As the illustration shows, a piece of pipe was fitted



HOME-MADE OIL-BURNER REGULATOR

with a piston, the rod of which was fastened to a lever controlling the valve in the burner steam line. Two springs were fastened to a yoke on the piston rod to resist the pressure exerted on the piston by the steam. When the boiler pressure rose above normal, the movement of the piston closed, partly or entirely, the burner steam valve. The flow of steam being reduced, the amount of oil forced through the burner was likewise decreased. The control of the burner was excellent and apparently was in every way equal to that obtained by the use of an expensive regulator.

Pocatello, Idaho. F. M. COXIE.

What Caused the Machines To Be Out of Phase?

In our plant we have two frequency converters, each consisting of a 40-cycle 8-pole motor and a 60-cycle 12-pole alternator, running 600 r.p.m. and operating in parallel except on Sundays, when only one machine is used. Recently, on starting the second set, it was put in parallel with the other machines as usual. but about two hours later there was a heavy overload and the switch opened in the main power house. This switch was closed immediately and we proceeded to start both converters.

After No. 1 set of machines had been started, we noticed that the polarity was reversed on the direct-current voltmeter and ammeter. This was corrected by reversing the leads to both meters. On plugging in the synchronizing receptacles, the synchroscope showed 90 deg. out of phase, slow. The machines were shut down and we proceeded to get them back in step, which was accomplished after shifting the motor's stator one pole 90 deg. Of course, if the synchroscope had showed 180 deg. out of phase, the field switch could have been reversed and the machine would have come into phase. I would like to know what caused the exciter to reverse and why the machines were 180 deg. out of phase.

GEORGE A. BASSETT.

Lyon Mountain, N. Y.

The Wrong Way To Design a Steam Plant

A comparatively large and costly office building was erected some time ago, and the steam plant that was used to heat and ventilate it was designed to utilize space in the cellar without the slightest regard for burning coal to good advantage, nor for the convenience of the engineer in charge, while operating the machinery in daily service and making necessary repairs.

In the rear of this building there was a large space that was utilized for flower beds, making a fine appearance but adding nothing to the practical value of the plant. The corporation that erected this building had plenty of money for this purpose, and as several other plants were operated by it, the owners were not ignorant of the principles involved nor of the best methods for securing economy in the use of fuel.

This steam plant consists of three return-tubular boilers 16 ft. long, 54 in. in diameter, and each one contains 58 three-inch tubes. If the floor of this boiler room had been lowered 4 ft. it would have made a great difference in the appearance of the whole plant. The ashpits were so low that they would hold but a small quantity of ashes, hence if they were not cleaned frequently there was danger of melting out the grates. The architect had a special type of boiler front cast so as to bring the grates as low as possible. They were also designed to make a very low furnace; the consequence was that when the fireman put fresh coal on the fire, he had to stoop down into a very unnatural position.

After these changes had been made, the distance from the top of the shell to the ceiling above was but two feet. A breeching 3 ft. square was required but there was not sufficient room for it above the boilers, so it was located on the side of the setting and was installed with the top at least 4 in. down from the ceiling; hence the bottom of it is about 16 in. lower than the tops of the boiler shells. From the side of this breeching to the fronts the distance is only 20 in., and in this space is located the combination water column, with gage glasses and try cocks.

When the boilers are operated under normal load, the temperature of the breeching is about 500 deg. When a gage glass breaks it is necessary for the engineer to work in this narrow space subjected to the heat from the breeching while putting in a new glass.

There are no domes on these boilers because there is no room for them. Steam nozzles are riveted to the shells, and the safety valves are bolted to these nozzles. From the tops of these valves to the ceiling, the distance is only three inches. The manhole frames are riveted to the tops of the shells. The clear space at this point being about 21 in., when a man enters a boiler, he must crawl along this space, then double himself up until he can worm his way into a 11x15-in. manhole, and again turn himself in a space about 20 in. high at the highest part.

It will be remembered that the safety valves, stop valves, top feed valves and others are all in this low space, hence when the safety valves need grinding in, or any of the other valves need new disks or the stems need packing, such work must be done at a disadvantage. Flange joints must also be repacked in this limited space.

The distance from the rear wall of the setting to the wall of the building is 20 in., although it could have been made 6 ft. without causing trouble elsewhere. The blowoff valves are in this space, and there should have been sufficient room to open them with a lever at least 24 in. long without binding on the brickwork. The blowoff pipe of a steam boiler is one of the most dangerous features of the steam plant, and in the event of failing under pressure while the engineer or the fireman is at the rear of the boiler, there should be plenty of room to escape, or serious injury may result. This matter is not given due attention, hence it is mentioned here that a remedy may be applied when a new plant is installed or when extensive changes are made on an old one.

Windows might have been located opposite each boiler, so that soot and ashes could have been taken out easily, but this important point was entirely overlooked. Windows were installed, but they were only 14x31 in., hence were much smaller than the boilers, so that a tube scraper could not be used from the rear end. Large windows were put in the main wall of the building, but they were arranged to give a good appearance from the outside rather than to be utilized while operating the boilers. This made it necessary to use a jointed tube cleaner rod, which is always a nuisance.

From a point where the fireman stands to attend to the furnace, to the engine, it is nearly 300 ft., therefore either the exhaust steam must be conveyed a long distance to utilize the heater, or else the feed water must be heated near the engine and pumped many feet to the boilers. Either plan used results in waste of heat, and considerable time is spent each day in walking from one part of the plant to the other.

The mainshaft of this plant is near the cylinder head of this engine, and to this extent the plant is compact, as the main belt runs backward from the flywheel to the main pulley. Nobody deserves special credit for this, as there was room enough to lay out the belt drive so that it would be to the best possible advantage.

New Haven, Conn. W. H. WAKEMAN.

Comments from Readers

Lost Research

The editorial, "Lost Research," in the July 31 issue appealed to me as hitting the nail on the head in regard to library indexes in general and engineering ones in particular, such as the United Engineering Societies Library in New York, although this latter one was not referred to by name.

Library indexes or collateral guides do not cover the field of research so as to enable one to know in what classes of books, periodicals or pamphlets information on even any prominent subject exists, or by what kinds of authors such information is likely to be produced, or where or in what location or collection such information is available, and whether in the engineers library or elsewhere, and whether *all* of it is so covered.

The investigator may know this from long experience or practice, but those without this experience and the library attendants lose a lot of time in the absence of such guides.

You say "No real solution of the difficulty is in sight, but much improvement might be brought about by active co-operation of skilled technical libraries with the professional engineering societies in a thorough study of the whole problem of the conservation of engineering knowledge. Engineers will rise up and bless the man who will show them how to locate *all* the published information on any desired engineering subject."

The only way to do this is to begin, and the way to begin is to draw up forms for recording this information as it comes before the library staff in their own researches or by contact with those making researches on particular subjects; these forms to be on lines that will readily suggest themselves, to be "cut and tried" till the best forms are produced.

A librarian cannot sit in a corner room and leave it to girl attendants to work out such a system. There must be a live-wired, inventive, analytical, engineering male mind with his head in the machinery, so that he can hear the grating and groaning and get the reaction and static discharges from the users, record the trouble mentally and follow the lines of research pursued by searchers, jot them down on temporary forms or blanks for the permanent records and use of all so that it will not be forever dependent on any one person's brain, and finally get them into shape for users at call.

Of course the procedure and blanks for a machine or process would be different from those of a general subject or historical research on such subjects as railways or canals. I have drawn up one or two, but the libraries probably know better what shape the forms could take if they only had the idea or the starter.

It has been my experience that the library indexes or card catalogs, while quite necessary and valuable to indicate the places where everything is kept and to give some classified arrangement of the subjects and authors, are almost useless to the engineer unless he knows the exact name of the particular book or periodical or author, and what the word author means, and the reasons for the particular filing system of cards that exists and the most comprehensive or direct ones to look at, if he wishes to do his own researching or has a vague idea of what he will find and doesn't want to use the attendants.

There should be more elucidating guides to the rapid use of these card catalogs, but, as you say, they do not cover the field thoroughly although a beginning may have been made in devoting boxes to particular subjects instead of to an alphabetical arrangement in the same box of all kinds of subjects.

There is one line for instance in which the library gives no evidence of being of any service and that is in maps, except in United States Geological ones. American engineers are world-wide developers and yet are ignorant to a large extent of the world's geography. Of course there are atlases, but no evidence of a globe or wall maps or maps pertaining to such subjects as water resources or city plans or transportation systems, nor any way for the stranger to discover how to get this information or where to see it. Who knows where you can see harbor maps of any port in the world, or how to find topographical surveys of almost any part of the globe, or where he can see the profile of some great river or the contour of its great water powers, without going thousands of miles to see them and at prohibitive expense? Should not the library have such information available for engineers as well as the kind of stuff it has in its own stock? HOWARD P. QUICK.

New York City.

Reminiscences of a Veteran Mechanical Engineer

I read with much interest Mr. Odell's article "Reminiscences of a Mechanical Engineer" in the July 10 issue. The cut of the Corliss steam engine shown however is not one of the engine as built by Corliss. It is a Harris-Corliss as built by Wm. A. Harris at a later date, and is readily identified by the self-packing valve bonnets and the dash-pots under the floor. These dash-pots were not of the vacuum type, but were heavy weights falling into cushion-pots, and a trap-door was placed in the floor to permit the engineer to adjust the cushion.

The original girder frame Corliss engine, as I knew it, was an oddity as compared with the styles generally known today. The well-known wrist-plate was pivoted on a stud in the frame about midway between the cylinder and the rocker arm and the steam and exhaust rods ran in a horizontal manner to the respective valve stems. The dash-pot rods ran from the bell-cranks on the steam valve-stems, back horizontally to a point about midway between the wrist-plate and rocker arm where a bracket held the two dash-pots—these dash-pots were "cushion-pots" only, while the power to close the

steam valves was supplied by two leaf springs some 3 ft. long, fastened to the floor.

My information is, that this was about the earliest form of the Corliss engine, and I never saw but two, one of which was running in a mining plant in North Carolina. This engine I had the occasion to indicate and to make some adjustments and minor repairs. I found the piston to be "perfectly tight" and I obtained as fine an indicator diagram as I ever got from any engine. It was a 16x42-in. engine running 75 r.p.m. and was set on timbers buried in the ground.

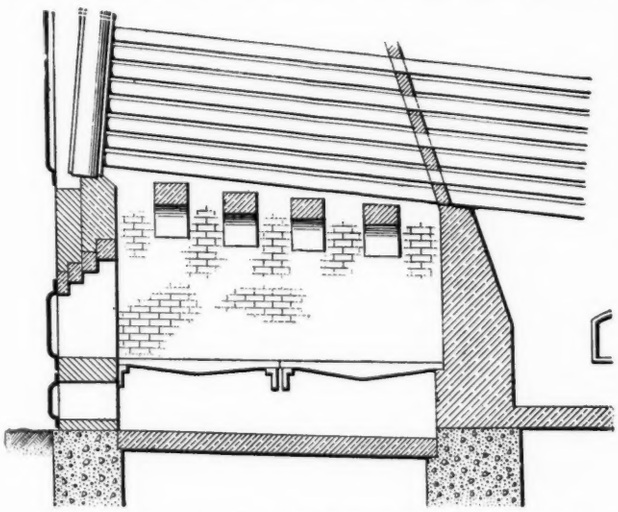
It would be interesting to the younger generation of engineers if a cut of this early type of engine could be shown. M. V. WHITE.

Cincinnati, Ohio.

[In editing Mr. Odell's article an attempt was made to secure a picture of the original Corliss engine; search was made at the New York City Public Library and also the Engineers Library, but there didn't appear to be any illustration in existence. We were aware that the cut shown was one of the Harris type. It was a reproduction from an illustration in Robert H. Thurston's "Manual of the Steam Engine," published in 1891 and was used to present one of the earlier types of Corliss engine.—Editor.]

Will Change from Vertical to Horizontal Baffling Increase Furnace Temperatures?

Referring to the inquiry of F. Williams in the July 17 issue, "Will Change from Vertical to Horizontal Baffling Increase Furnace Temperatures," I recommend that before changing from his present arrangement of baffling he try the sectional-arch plan shown in the illustration. This type of arch was formerly much used on vertically baffled water-tube boilers where high ratings were to be obtained with hand-fired small-sized anthracite. This gave sufficient screening action from the cold tube surface to give prompt ignition and rapid combustion and yet retained the advantages of the superior heat absorption and diminished draft resistance of the vertical baffling arrangement due to reduction of dead corners and easier cleaning.



SECTIONAL IGNITION ARCH FOR BURNING SMALL-SIZED ANTHRACITE

Furnace temperature is not so directly related to efficiency as other factors, such as direct absorption of radiant heat from the fire, which tends to lower the furnace temperature and at the same time increase total efficiency, as less heat is left to be absorbed from the gases of combustion by convection. In fact, the trend of modern furnace design is in this direction, as otherwise such high temperatures are generated by the high rates of combustion at an air supply very little above theoretical, that the life of the firebrick furnace linings is very much shortened.

Accurate measurement of furnace temperatures is difficult, as the temperature of the surface of the fuel bed may be different from that visible in the crevices an inch or so below and the surface again different from that of the gases of combustion, not to mention variations from side to side of the furnace.

Radiation pyrometers may be used on the fuel bed if the radiation coefficient is known, but they will not give even approximate results on the gases of combustion. Experiments by the Bureau of Mines show that at these temperatures the radiation from thermocouples to the tubes and furnace walls is sufficient to cause errors of two or three hundred degrees in measuring the temperature of the gases. For these reasons anything more than an approximate statement of furnace temperature is difficult, and the criterion of efficiency is to be looked for more in the composition and temperature of the flue gases leaving the boiler.

The best fire with small anthracite is such a combination of fire thickness and draft that it appears to be slightly boiling on the grate, and care must be used in firing to spread the coat thinly and evenly so as not to burn any one spot thin, though this tendency is reduced by the main restriction to the floor of air being in the perforations of the grates and restraining the tendency for the whole air supply to concentrate at one spot as soon as it gets thin there and thus accelerate its burning out. H. D. FISHER.

New Haven, Conn.

By the arrangement of baffles suggested by Mr. Williams, the transmission of heat by radiation would be greatly reduced and this would tend to reduce materially the rating that could be obtained from the boiler. The latest practice is to make the transmission by radiation as great as possible. Also the horizontal baffles will tend to cause dead pockets and thereby slow up the circulation and decrease the heat transmission, which in turn would cause the gases to leave the boiler at a higher temperature, and since the outlet for the gases is above the drum, this would be objectionable.

Mention is made of poor furnace efficiency. Since forced draft is used with a hand-fired grate, it is not unlikely that holes are blown in the fire bed and too high excess air is used, thereby causing the low temperature. It is my opinion that with the same hourly consumption of coal and the same forced draft, in spite of the change of baffles the furnace temperature would not be any higher. The furnace temperature cannot be regarded as a reliable indication of furnace efficiency. This is best obtained by gas analysis.

From experience I would suggest that no change be made in the baffling, but that the forced draft be used only if absolutely necessary, and if it is used, that some experimenting be done to ascertain the proper thickness of fuel bed for the best results. It would also be of advantage to lower the grates, if this is possible, in order to get a larger combustion space. HANS COERPER.

Brooklyn, N. Y.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Position and Durability of Boiler Patches

Should boiler patches be placed inside or outside of the shell, and can patching be made as durable as the rest of the boiler? L. B. H.

A good job of fitting, riveting and calking usually can be done to make the patched part as strong as the rest of the shell. Patches in the fire side of a boiler should be placed on the inside of the shell, not to assist in preventing the patch from being blown off, but to avoid the formation of a pocket for collection of sediment that would endanger the patch to burning out. Patching sometimes gives trouble from formation of fire cracks extending from the rivet holes to the edges of the plate. Such cracks once formed, gradually grow worse and open until the leakage makes it necessary to remove the patch and replace it by a larger one, and in this respect a patch may not be so durable as the rest of the boiler.

Steam Valves of Duplex Pumps Without Lap or Lead

Why do not the steam valves of direct duplex steam pumps have lead and lap the same as ordinary slide-valve engines? W. G.

The steam valves of a direct duplex pump should not have lead or lap, since there is no flywheel or other means of storing energy for carrying the piston to the end of the stroke and the steam pressure for moving the piston must be sufficient for overcoming the resistance to pumping for the full stroke. If cutoff should occur before the end of the stroke, the pump could not be operated at very low speeds and could not be started from a point of the stroke after the valve had closed. Lead would have the effect of shortening the stroke and would be unnecessary for cushioning, since that may be accomplished by compression.

Overheated Main Bearing

What is the cause for overheating of a main bearing of an engine, and when overheating occurs, is any harm done by cooling the bearing with a stream of water? H. C.

Overheating may be due to receiving an irregular or insufficient amount of oil; the bearing may be out of line; use of an unsuitable lubricant; or overheating of a main bearing may be caused by too little compression in the steam cylinder, which should act like a cushion for overcoming inertia of the reciprocating parts at the end of a stroke. When there is no compression, the bearing is alternately subjected to high and low pressure, which is likely to impair the uniformity of lubrication. Cooling a bearing by a stream of water may result in serious distortion and should not be practiced except as a last resort in cases where the engine must be kept running until it may be shut down for repairs. When a bearing becomes overheated, it should be loosened up all around and given a generous supply of cylinder oil, or fed with a mixture of one part graphite and ten parts of heavy engine oil, and the bearing should be examined at the first opportunity to see that the oil feeds have not become clogged. When trouble occurs from overheating in a babbitted bearing, any spots that appear darker than the rest are the high spots and should be scraped. If a brass or bronze box becomes overheated, it probably will be distorted and should be refitted.

Hammer Test of Boiler

Is a hammer test of a boiler sufficient for determining the condition of the material? W. N. C.

Sounding with a hammer requires practical experience in determining whether the plates are injured by blistering or wasting, and a hammer test may reveal conditions of dangerous weakness that would not be made apparent by pressure tests. The location of stays, joints and fittings and the presence of boiler scale may affect the sound, so that a hammer test is not necessarily conclusive of imperfection of the material; but when a supposed defect is located, the parts should be thoroughly examined, and when this applies to the boiler shell, a hole should be drilled through the sheet to determine its thickness and condition.

Cause of High Head Pressure

The suction pressure in our refrigerating plant is 3 lb. gage, the head pressure 155 lb. gage, while the "on" temperature of the condensing valve is 53 deg. and the "off" temperature is 80 deg. With the compressor shut down the "on" water temperature is 53 deg., "off" temperature 54 deg. and the head pressure 98 lb. gage. Why is the head pressure while operating so much higher? E. G. G.

The 98 lb. head pressure corresponds to a condensing temperature of 63 deg. F. and since the "off" water temperature is 54 deg. corresponding to a condensing pressure of 81.5 lb. gage it is apparent that there is but little foreign gases in the condenser.

Since, when operating, the head pressure rises to 155 lb. gage corresponding to a condensing temperature 86 deg. F., the rise in water temperature from 54 to 80 deg. would indicate that there is insufficient water or an insufficient amount of cooling surfaces. With such cold water, the temperature going "off" ought not to exceed 68 to 70 deg. F., and this would decrease the head pressure to about 125 lb., thereby reducing the power consumption of the compressor.

Percentage of CO_2 for Best Efficiency

Is a high percentage of CO_2 in boiler flue gases always representative of best efficiency? W. L. C.

In plotting efficiencies obtained in numerous boiler tests and comparing them with the results of analyses of the chimney gases, it is found that the maximum efficiencies are obtained when the CO_2 is between 14 and 15.5 per cent, but when in excess of 15 per cent the efficiency may be either at or near the maximum or may be considerably below it, since the high percentage of CO_2 may be accomplished with high CO, indicating a loss due to imperfect combustion. The probability of lowering the economy is so great when 14 per cent CO_2 is exceeded, that in ordinary boiler practice it is better not to attempt to exceed that percentage.

Removal of Gas from Well Water

After putting down a 300-ft. well for a supply of cool drinking water, the water is found to have a milky appearance for some time after it is drawn up by a deep-well pump. The water is tasteless and the cloudiness disappears after it has been allowed to stand about half an hour, and it has been proposed to utilize the water for boiler feeding. Is such water likely to be harmful to the boilers? S. N.

The temporary clouded appearance of the water undoubtedly is due to release of dissolved air or other gases, which usually can be liberated as the water is drawn by providing each faucet with a tip for spreading out the discharge into a broad thin filament like the flame of a fishtail gas burner. Analysis of the water should be obtained to determine its suitability for use as a drinking water and for boiler feeding. It is probable that the white appearance when first drawn is due to liberation of carbonic-acid gas, which is harmless in drinking water, but unless discharged before the water is fed to a boiler will combine chemically with the material of construction and cause rapid corrosion. To test for carbonic acid, add clear lime water to a sample, and if carbonic acid is present a permanent milky precipitate will be formed. For boiler feeding the air and carbonic-acid gas that water holds in solution are largely liberated in an open feed-water heater at about 210 deg. F. If the separation takes place in the heater, the air and carbonic-acid gas will pass out through the vent to the atmosphere and no damage will result.

Averaging Readings of Spring Pressure Gage

Will a throttled spring pressure gage on the force pipe of a pump give correct indications of the average pressure? F. L. C.

Throttling a gage connection reduces the amplitude of the vibrations of the gage, but cannot dampen the pressure to obtain a steady reading of the true average pressure, such as could be interpreted from the diagram of a perfect steam-engine indicator registering the pressure on a chart moved at a uniform speed.

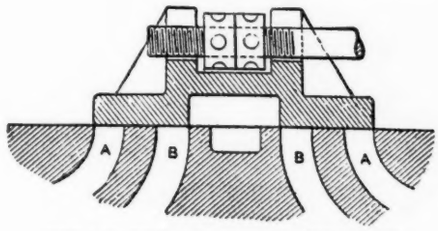
When there are pulsations of the pressure, the best information available with an ordinary spring pressure gage is to assume that the average pressure is the reading corresponding to the mean amplitude of vibration of the pointer. But, as readily ascertained by comparing such gage readings with varying pressure recorded by a steam-engine indicator, such mean readings are generally higher than the true average, depending on the strength and frequency of the variations of pressure and volume of displacement, elasticity and inertia of the gage parts.

Although the apparent average readings of a throttled spring pressure gage may be regarded as close enough for many practical purposes, when it is important to determine average pressures with strict accuracy, they should be obtained with an indicator or other type of pressure-recording gage without throttling, using an instrument that is only slightly affected by the inertia of moving parts and with the chart or "card" drawn out at sufficient speed for interpreting the duration as well as the magnitude of fluctuations of the pressure.

Cushion of Steam Pump

How is cushioning obtained in a direct-acting steam pump? J. C. A.

Cushioning of a steam pump is obtained by compression of the steam that may be in the steam cylinder as the piston nears the end of an exhaust stroke. In the



STEAM PORTS OF DUPLEX PUMP

ordinary duplex pump this is accomplished by having two ports, *A* and *B*, shown in the figure, in each end of the cylinder. The outer ports act as the steam admission ports, each terminating at the end of the cylinder so as to guide the incoming steam into the clearance space behind the piston; the other ports *B* acting only as exhaust ports and terminate a short distance from the heads.

The piston, in approaching a cylinder head covers the exhaust port *B* in the same end of the cylinder and steam then remaining on the same side of the piston becoming compressed in the end of the cylinder and clearance spaces during the remainder of the stroke, thus acting like a cushion in bringing the piston to a stop. On the larger duplex pumps, a passage is provided between each port *A* and its corresponding exhaust port *B*, and a valve is inserted which can be opened for escape of part of the compressed steam port *A* to port *B* should the piston cushion too heavily.

Negative Lead

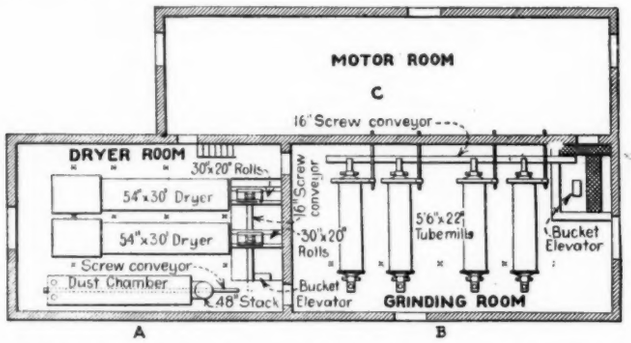
What is meant by the term negative lead of a valve? R. C. M.

Lead of an engine valve is the amount the valve is open at the beginning of a stroke of the piston. When a steam valve does not open until after the beginning of the stroke, it is said to be late, and negative lead is the distance the edge of the valve would have to be moved to begin uncovering the port when the piston is at the beginning of a stroke. With negative lead steam is not admitted until after the piston has started off in its stroke, and unless there is excessive compression, the full steam-chest pressure is not likely to be realized during any portion of a power stroke.

Explosion in Coal Preparation Plant

The following facts, of interest to powdered-coal users, have just become available for publication:

On the evening of Jan. 9, 1923, an explosion occurred in the coal-preparation plant of the Hercules Cement Corporation, Stockertown, Pa. The main building of the grinding plant in which the explosion occurred is 146 ft. long by 46 ft. wide, with a leanto at the side 100 ft. long by 20 ft. wide. The construction of the building consists of masonry walls 2 ft. thick and 36 ft. high on which rest steel roof trusses supporting a corrugated iron roof. The



LAYOUT SHOWING WHERE EXPLOSION OCCURRED

building is divided into two sections by a stone partition wall about midway. The general layout of the building and equipment is shown in the illustration.

In the section *A* there is a second floor of structural steel and concrete on which are the shafting and transmission machinery, the exhaust fans for the drier and the storage bins for the incoming coal. On the ground floor are two driers and two 30x20-in. rolls with the necessary elevating and conveying machinery; also a concrete dust chamber approximately 7x34 ft. and 18 ft. high. In the section *B* there are four 5½x22-ft. tube mills, storage bins and the necessary conveying and elevating machinery.

The entire equipment is electrically driven. All the motors, starters, etc., are in the leanto *C*. There are no motor or high-tension circuits in the main building. The 110-volt lighting circuit is installed according to Underwriters' standard.

Coal is delivered by a belt conveyor to the receiving bins on the second floor of the section *A*. It passes from these bins to the driers and then to the rolls, where it is reduced to pea size and under. From the rolls it is transported by conveyor and elevator to the bins in the section *B;* from these bins through the pulverizing mills and then by conveyor and elevator to the kiln room situated approximately 300 ft. away.

The driers are fired by mechanical stokers. Exhaust fans on the second floor of the section *A* draw the moist air from the driers and discharge it through the concrete dust chamber to the atmosphere. The coal dust that settles in the bottom of the chamber is removed by a screw conveyor.

Very little is known as to the cause of the explosion. From the details given in the sworn statement of the night foreman, the only survivor of five workmen at the plant, it would appear that it had been operating as usual but, owing to some trouble with the conveyor in the dust collector, that part of the plant was shut down until repairs were made.

When repairs were completed, the conveyor was operated some little time before starting the rest of the machinery in order to make sure that everything was operating properly. The other machinery was then started. The drier fireman went to the second floor, threw in the clutch in the drier and came downstairs. A short time later there was a burst of flame, followed almost immediately by a second explosion. All the windows in the plant were blown out, and the roof was blown up on one end of the building. The dust chamber was damaged but not blown out.

It would appear from the information obtained that there were two separate explosions—the first one probably in the dust chamber and the second one throughout the plant. The initial cause could not be determined. It is probable, however, from a study of conditions that the accumulation in the dust chamber and the draft from the drier might produce a condition where spontaneous combustion could take place.

Temperature Indicators for Turbo-Generators*

With the adoption of forced ventilation of turbo-generators requiring a totally inclosed machine, the thermocouple or embedded temperature coil became a necessary factor in determining the temperature rise of units under test conditions; following this use, the manufacturers began installing these devices for permanent record of operating temperatures. This record was, however, in most cases simply a matter of test data or of checking temperatures at periodic intervals to determine the condition of the unit as regards air flow, ventilating duct, etc.

When manufacturers increased the temperature of turbo-generators due to increases allowed by revised A.I.E.E. rules, many operators installed switchboard-type temperature-measuring instruments to permit reading the temperature at regular intervals and thereby keep in closer touch with actual machine performance. A demand was thus established for a curve drawing type of instrument which is now on the market and in use by a number of companies.

These instruments are usually of the eightpoint type, permitting the connection of six embedded coils, and inlet and outlet air. The practice of operating companies is interesting in regard to the installation of these devices. Some companies are installing them on all generators, some on all new generators, and some only on generators that show a relatively high temperature under ordinary operating loads. A total of 36 have been installed to date—24 for steam turbo-generators and 12 for waterwheel units.

Various operating companies have reported trouble with temperature coils, both before and after they have been in service. These troubles, consisting of either grounds or open circuits, were probably due to weak mechanical construction or insulation defects that became evident after the main windings in which these coils were embedded were forced into place. On a system operating seven generators equipped with temperature coils, a total of twenty-two coils have become open circuited. On another system operating nine generators equipped with these coils but one coil has given trouble. Other companies show records between these whereas some report no trouble whatever. In addition to open-circuit troubles some cases of ground have been reported due to the breaking down of the fuses in the film cutouts. The manufacturers have recently improved these conditions by making stronger leads, providing better armor where the leads come out from the armature frame, making better connections from leads to temperature coils, and improving the protection of the detector itself so that it cannot be easily crushed between armature coils.

Another development which will tend to reduce trouble is the curve-drawing instrument previously mentioned, which operates from a standard cell, whereas all previous types required 125 volts for operation.

Mention has been made in this report for the last two years of the series of tests made on large turbo-generators by the co-operation of certain manufacturers and operating companies. The results of this investigation have not been made public as yet, but from the data obtained and also considering the discussion of this subject at the 1922 convention of the A.I.E.E., it seems certain that two noteworthy steps will shortly be taken—first, the agreement of manufacturers to design machines for radial ventilation and a maximum temperature of 125 deg. C. (80 deg. observable rise) instead of the present dual standards of 105-150 deg. C., and second, a standardization of the use of 20-in. embedded temperature coils for all generators.

*Abstract from the N.E.L.A. Electrical Apparatus Committee's 1923 report, presented at the forty-sixth annual convention, June 4-8, New York City.

News in the Field of Power

Choosing the Boilers for Detroit Municipal Plant

THE Public Lighting Commission of Detroit, after an extended study, decided that the requirements of their new station would be best served by cross-drum water-tube boilers. In accordance with this decision, Smith, Hinchman & Grylls, the engineers employed to carry out the project, sent out specifications on Jan. 8 of this year calling for bids on boilers of this type. Bids came back on six such boilers, and a seventh, on semi-vertical bent-tube boilers, was received and tabulated with the others. Matters of finance delayed further action until June 1, when the commission considered the propositions submitted and requested permission of the city council to award the contract for the eight boilers and eight superheaters to the Babcock & Wilcox Co. Objections being urged by lower bidders, a public hearing was held by the council on Aug. 13, at which the merits of the different boilers offered were set forth, and the council appointed a committee consisting of W. B. Mayo, engineer of the Ford Motor Co., T. H. Hinchman, of the engineering firm in charge of the project, and J. C. McCabe, former boiler inspector and at present head of the City Research Bureau of Detroit, to consider the arguments presented and report the following week. The report of this committee, submitted Aug. 20, sustained the recommendation of the commission.

The bids are given in the accompanying table, but a reduction in the size of the boilers to 13,700 sq.ft. reduced the bid by $40,128, making the price $331,456 for the eight boilers and $66,960 for the superheaters.

As announced in *Power* of April 17, page 616, this installation is to consist of four 20,000-kw. turbo-generators, each served by two boilers designed for 350 but to be run at about 300 lb. and 200 deg. F. superheat, using powdered coal. With the street railways taking about 73 per cent of the generated energy and the municipal light and power demand taking the remainder, the load is expected to fluctuate between wide limits. With only 1.37 sq.ft. of steam-making surface provided per kilowatt of generator capacity, the boilers will probably have to be run at times to 300 per cent rating or over.

In the opinion of the commission the single-cross-drum straight-tube type of boiler was best adapted to these conditions, and the avoidance of transverse seams in the drum and the use of forged steel headers appeared to them to warrant the additional cost of the Babcock & Wilcox boilers.

Another fact, however, complicated the award. The engineers were desirous of using boilers of the two-bank type with the superheater between the upper and the lower bank of tubes. Patents have been issued to the Babcock & Wilcox Co., which it claims control the location of a superheater in this position, but the validity of which is in contest in suits between the Babcock & Wilcox Co., the Superheater Co., and

SCHEDULE OF BOILER BIDS FOR DETROIT MUNICIPAL PLANT

Bidder		Babcock & Wilcox Co.		D. Connelly Boiler Co.		D. Connelly Boiler Co.		Heine Boiler Co.		Geo. T. Ladd Co.		Wickes Boiler Co.		Springfield Boiler
Address		New York		Cleveland		Cleveland		St. Louis		Pittsburgh		Saginaw, Mich.		Springfield, Ill.
Price—six boilers		$279,438.00		$204,900.00		$195,900.00		$290,200.00		$164,500.00		$203,051.00		$206,000.00
Price—eight boilers		$372,584.00		$273,200.00		$261,200.00		$377,800.00		$215,100.00		$270,382.00		$273,000.00
					% Tolerance		% Tolerance		% Tolerance		% Tolerance		% Tolerance		% Tolerance
Delivery time		First boiler 21 weeks, one boiler per month thereafter													
Erection time		Six boilers within 40 weeks from delivery of first boiler		28 wks.	20	28 wks.	20	52 wks.	10	32 wks.	10	30 wks.	20	22 wks.	20
				36 wks.	20	36 wks.	20	68 wks.	10	4 wks.	10	8 wks.	20	9 wks.	50
			% Tolerance												
Net weight per boiler, lb.		297,000	.....	280,000	10	.....	.....	380,000	.....	210,000	5	230,000	10	270,000	5
Water-holding capacity, cu.ft.		1,761	.....	2,260	5	.....	.....	925	.....	1,700	1	1,720	5	1,314	5
Maximum moisture in steam at nozzle, evaporation 110,000 lb. per hour		1%	.....	1%	15	1%	15	0.75%	.....	1%	None	1.5%	30	None	None
	Lb. per Hr.														
Draft loss (inches of water) through boiler when weight of flue gas is	85,000	0.17 in.	10	0.10%	15	0.10%	15	0.14%	5	0.25%	2.5	0.20%	15	0.20%	25
	173,000	0.84 in.	10	0.43%	10	0.43%	10	0.60%	5	0.55%	2.5	0.40%	15	0.55%	36.4
	260,000	1.75 in.	10	1.43%	5	1.43%	5	1.60%	5	1.20%	2.5	0.65%	15	1.25%	28
Flue-gas temperature at outlet when furnace temperature is 2,400 deg. and weight flue gas is	85,000	480°F.	10	460°	5	460°	5	509°	5	490°	2.5	485°	10	475°	2.1
	173,000	570°F.	10	535°	5	535°	5	569°	5	550°	2.5	520°	10	530°	4.7
	260,000	675°F.	15	640°	5	640°	5	632°	5	680°	2.5	575°	10	600°	6.6
Efficiency boiler and superheater when furnace temperature is 2,400 deg. and weight of flue gas is	85,000	76.7%	0.5	77°	2	77%	2	77%	3	78.8%	2.5	92.2%	2.5	79.5%	1
	173,000	74.5%	0.5	74.5°	2	74.5%	2	74.3%	3	75.2%	2.5	90.3%	2.5	76.5%	1
	260,000	70.5%	0.5	67.5°	3	67.5%	3	71.8%	3	71.5%	2.5	87.3%	2.5	73.5%	1
Type boiler		Horizontal Water Tube, One Cross Drum		Horizontal Water Tube, Two Cross Drums		Horizontal Water Tube, One Cross Drum		Horizontal Water Tube, One Cross Drum		Vertical Water Tube, Three Cross Drums		Horizontal Water Tube, One Cross Drum		Horizontal Water Tube, One Cross Drum	
Type header and material		Sectional, Forged Steel		Sectional, Cast Steel		Sectional, Cast Steel		Sectional, Cast Steel		.....		Box, Steel Plate		Sectional, Cast Steel	
Heating surface, sq.ft.		15,920		15,956		.....		15,740		15,300		15,630		15,800	
Size drum, in.		54		44		54		54		Two 42 in. One 48 in.		54		54	
Thickness drum, in.		1.125		1		.....		10,625		42 in.-1.5 48 in.-1.6875		.....		1.125	
Size tubes, in.		4		4		4		3.5		3.25		4		3	
Gage tubes, b.w.g.		No. 7		No. 7		No. 7		No. 8		No. 9		.....		No. 9	

the Springfield Boiler Co. The bid for the superheaters by the Superheater Co. was some $12,000 less than that of the Babcock & Wilcox Co. and their Elesco superheater was favored by the Commission, but in view of the patent situation no agreement could be arrived at whereby this superheater could be used in the Babcock & Wilcox boiler.

The commission was in the position, therefore, of being willing to pay the additional price for the product which it considered best adapted to its purposes, but subjected to an additional charge of some $12,000 for the right to place its superheaters as it considered best, the control of this right being, however, in dispute. The desired superheater arrangement was considered enough better to warrant the expenditure, as it is claimed that the superheater in the interdock or intermediate position gives less variation in superheat at different boiler ratings than will a superheater placed between the boiler steam drum and sections in the horizontal water tube type of boiler which has been the customary position up to this development of the Babcock & Wilcox Company. This was agreed to, and the council, sitting as a committee of the whole to receive the report of its special committee, voted to recommend the award of the contract upon these terms to the Babcock & Wilcox Co. When, however, this recommendation of the committee of the whole was considered in formal meeting, one councilman objected, and at last accounts the award had not been made.

Anthracite Production Greatest on Record

According to figures given out by the Federal Fuel Distributer, the production of anthracite during the first seven months of 1923, the greatest on record, was estimated at 59,569,000 net tons The year when production came nearest to these figures was 1918, with a production of 59,226,000 net tons.

There was received in the New England States during the first six months of 1923, 6,428,000 net tons of anthracite, also a record figure.

The export of anthracite for the first six months of 1923 was 2,372,259 tons. Continuing at this rate for the remainder of the year, the exports for 1923 should about equal those of 1920, which were 4,824,776 tons.

Coal Commission Unable to Sample All Retail Coal

While the United States Coal Commission has done sampling in many municipalities of the retail coal trade, it is impossible for the Commission to make an investigation of all the retail coal dealers of America. The Commission's statement follows:

There seems to be a lack of information as to how far the United States Coal Commission has gone in the anthracite and intends to go in the bituminous industry with reference to the retailing of coal.

The Commission has done all that it could in the way of sampling in many of the municipalities of the country the retail coal trade, and will present the result of its investigation to the country, but it has not gone and cannot go into an investigation of all the retail coal dealers of America. An investigation of such a character could not be made short of $2,000,000 and when made would not be conclusive as to whether the citizens of a municipality were satisfied to pay the prices charged by the retailer for coal.

Citizens and municipalities must do something for themselves. If they believe that they are paying to the retailer an exorbitant profit, they should supplement the work of the Commission by local investigations.

It heartily approves all investigations that are being made to ascertain the profits of retailers in individual municipalities, the determination of profits, and any suggestions that can be made for the bettering, if needful, of conditions disclosed in the investigation of the subject.

New Steam Plant for Topeka

The Topeka (Kan.) Edison Co., it is announced by Albert N. Patten, assistant general manager of the McKinley interests, has acquired 50 acres of land below Tecumseh, a town situated on the Kaw River about six miles from Topeka, on which it will immediately erect a steam-generating plant that will have an initial rating of 15,000 kw. in two equal units, at a cost of $2,500,000. This plant will supply Topeka and surrounding territory, and after it is completed the present 6,000-kw. city plant will be used only to furnish heat and for emergency purposes.

French Coal Situation Improves

French coal production is increasing, and imports from Great Britain are picking up after a recent decline. There is a very good demand for deliveries during July and August, contracts for which have been made at 5s. to 10s. lower than those for May, but owing to the exchange fluctuations the price in francs is higher than during that month. Total deliveries of coal and coke from the Ruhr from June 10 to 20 amounted to 80,000 tons of each, while deliveries of metallurgical coke to the Society of Consumers of Blast Furnace Coke averaged about 5,000 tons daily, according to the Department of Commerce.

Dix River Project Started

A plant for 30,000-hp. hydro-electric development is now being built on the Dix River near Lexington, Ky., by the Kentucky Hydro Electric Co., which is backed by the Middle West Utilities Co., Chicago.

The rock-fill dam 800 ft. long and 270 ft. high above river bottom is about 2¼ miles above the mouth of the Dix River, which discharges into the Kentucky River. The head will be 235 ft. from river bed to crest of spillway section.

Exports from the United States, during the first six months of 1923, of generating apparatus including both alternating-current and direct-current, were valued at $2,025,171, a 6 per cent increase over the same period of 1922. Shipments of mechanical-drive turbines taken alone, however, were less this year than during the same period of 1922. Fractional horsepower motors gained largely over 1922, a total of 68,332 motors valued at $981,533 having been exported during the first six months of the year, according to the Department of Commerce.

In London, Ontario, most of the coal-generated plants have been discarded and every industrial concern has linked up with the hydro-electric system, according to an announcement recently made. By the exclusive use of hydro-electric power generated at Niagara Falls, the industries of the city effect a yearly saving of not less than 100,000 tons of coal. As 10,000 hp. of energy is provided yearly to London manufacturing plants, it is estimated that it would take between 150,000 and 200,000 tons of coal to produce the energy locally.

Tentative Program of the World Power Conference is Announced

Delegates' Time To Be Spent in Discussion as Papers Are To Be Printed in Advance

THE participation of Europe excepting Russia and Germany is now secure for the World Power Conference to be held in London during July, 1924. It is planned to feature a concise statement of the existing power situation in each country and to discuss conditions under which capital of one country can be invested in utility enterprises of another.

Following conferences with O. C. Merrill, secretary of the United States Federal Power Commission, and J. B. Challies, of Canada, officials of the World Power Conference announced their agreement on a tentative program. All papers to be presented will be printed and distributed in advance so that the entire time of the delegates at the meetings may be devoted to discussion. In addition to the conference in London Mr. Merrill and Mr. Challies discussed power matters with French officials.

British manufacturers are convinced that they will benefit greatly by improving the status of the engineer and a decided effort will be made to make the conference especially helpful to the professional engineer.

Mr. Merrill sailed, Aug. 22, for America fully convinced that the World Power Conference is to be an assured success.

Program of the First World Power Conference

Division I: **Power Resources.** ***Division II:*** **Power Production.**
Division III: **Power Distribution.** ***Division IV:*** **Power Utilization.**
Division V: **General.**

Division I

Section A: National Review of Power Resources.
1. General Survey.
2. Investigation of National Resources.
3. Power Resources Available and Utilized.
4. Administration.
5. Electrical Power Market.

Division II

Section B: Water-Power Production.
Section C: Preparation of Fuels.
Section D: Steam-Power Production.
Section E: Internal-Combustion Engines.
Section F: Power from Other Sources.

Division III

Section G: Power Transmission and Distribution.

Division IV

Section H: Power in Industry and Domestic Use.
Section J: Power in Electrochemistry and Electrometallurgy.
Section K: Power for Transport.
Section L: Power for Lighting and Illumination.

Division V

Section M: Economic, Financial and Legal.
Section N: 1. Research.
2. Standardization.
3. Education.
4. Health.
5. Publicity.
6. General.

Division I

Power Resources

Section A:

National Review of Power Resources:

This division is of interest to the whole conference and will comprise for each country:

1. *General Survey of National Power Resources, Developed and Undeveloped:*
   (a) Water power, fuel power, transportation, etc.; present practice and future developments.
   (b) Short historical review of development.
   (c) Attitude of governments toward development; short summary of legislation.
   (d) Financial policy regarding state and private ownership.
   (e) State encouragement in the development of cheap power.
2. *Investigation of National Power Resources:*
   National and local organizations for collecting data, functions and scope.
3. *Power Resources Available and Utilized:*
   (a) Water Power—Physical characteristics of available resources, developed and undeveloped.
   (b) Fuel—(1) Coal, (2) lignites, (3) peat, (4) oil, (5) gas. Review of uses to which resources are put, costs of power, location of industries.
   (c) Other Resources—Power used in: (1) Electric generation, (2) industry generally, (3) rail transport, (4) sea transport.
4. *Administration of Power Resources:*
   Administrative responsibilities, national and local.
5. *Electrical Power Market in:*
   (a) Central-station activities.
   (b) Industry generally.
   (c) Electrochemistry and electrometallurgy.
   (d) Pulp and paper industry.
   (e) Railway electrification.

Division II

Power Production

Section B:

Water-Power Production:
(a) General principles, conditions and requirements.
(b) Recent practice in civil engineering features.
(c) Recent practice in mechanical engineering features.
(d) Recent practice in electrical engineering features.

Section C:

Preparation of Fuels:
1. *Distillation of coal.*
2. *Pulverized coal.*
3. *Distillation of shale.*
4. *Oil refining.*
5. *Peat.*
6. *Et cetera.*

Section D:

Steam-Power Production:
1. *Steam Generation:*
   (a) Better utilization of solid and liquid fuels.
   (b) Boilers for higher pressures and superheating.
   (c) Any other useful aspect.
2. *Steam Utilization:*
   (a) Rotary engines, e.g., turbines.
   (b) Reciprocating engines, e.g., uniflow engines and other forms.

Section E:

Internal Combustion Engines:
1. *Crude-oil engines.*
2. *Gas and refined oil and spirit engines.*
3. *Any other form of internal-combustion engine, e.g., gas turbine.*

Section F:

Power from Other Sources:
1. *Wind power.*
2. *Et cetera.*

Division III

Power Transmission and Distribution

Section G:

Power Transmission and Distribution:
1. *Alternating-current transmission and distribution:*
   (a) Alternating-current generators and motors.
   (b) Alternating-current transformers.
   (c) Alternating-current switchgear.
   (d) Superpower stations—present and future.
   (e) Transmission lines and systems, with special reference to line design, transforming and regulating equipment.
   (f) Local distribution systems, design and operation.
   (g) Standardization of voltages and frequencies.
   (h) Underground cables for high voltage.
   (i) Submarine cables for power transmission.
2. *High-voltage direct-current generation, transmission and distribution.*
3. *Low-voltage distribution and electrical storage.*

Division IV

Utilization of Power

Section H:

Power in Industry and Domestic Use:
1. *Development of the use of power in industry and for domestic purposes with particular reference to electrical power.*
2. *Mechanical distribution and utilization of power.*
3. *Hydraulic and pneumatic distribution and utilization of power; distribution by steam.*
4. *Power in agriculture.*

Section J:

Power in Electrochemistry and Electrometallurgy:
1. *Developments in the use of power in electrochemistry and electrometallurgy, with special reference to electric power.*
2. *Applications of heat to evaporation, distillation and refrigeration.*
3. *Applications of electricity to:*
   (a) Electrostatic precipitation.
   (b) Elcetric furnace work; smelting, steel manufacture, carbide, nitrogen fixation, alloys, abrasives, etc.
   (c) Electrolytic work; aluminum, iron, etc.

Section K:

Power for Transport:

Development in the use of power for transport.

1. *Land Transport—Prime movers and systems of transmission for rail and road.*
2. *Water transport—Prime movers and transmission of power to propeller, e.g., reciprocating engines, turbines, Diesel engines, gears, direct drive, electric drive and other systems.*
3. *Air Transport—Prime movers and systems of transmission.*

Section L:

Power for Lighting and Illumination:
1. *Development in the use of power for lighting and illumination, with special reference to electric power.*
2. *Recent developments in electric lamps.*
3. *Recent developments in illumination.*

Division V

General

This division comprises a number of subjects which are likely to be of primary interest at the conference, but do not readily lend themselves to classification in the previous divisions. In many cases they are merely special aspects of the subjects already mentioned, and papers thereon will naturally fall in the appropriate section.

Section M:

Economic, Financial and Legal:
1. *Public and private ownership and operation; special conditions which have led to each; results achieved.*
2. *Policy and practice in the public regulation of power development, transmission, distribution and utilization.*
3. *Financial problems in power development, at home and abroad.*
4. *International problems in the development of power on international boundaries and in the interchange of power and fuels; power import and export.*

Section N:

General:
1. *Research:* Papers on research work and probable future developments are among the most important submitted to the conference and in general will be read in conjunction with the appropriate section.
2. *Standardization:*
   (a) International standardization.
   (b) Standard specifications for performance, quality and dimensions.
   (c) Standard conditions and specifications for testing; national testing codes.
   (d) Value of standardization.
3. *Education:*
   (a) Education of the artisan.
   (b) Education of the engineer.
   (c) Education for commerce.
4. *Health:*
   (a) Industrial conditions.
   (b) Fatigue.
   (c) Psychology.
5. *Publicity:*
   Various aspects.
6. *General:*
   (a) Any subject of national importance or general interest presented by any national committee.
   (b) International co-operation.
   (c) Permanent organization.

Diesel Engines Exported During May

Exports of stationary internal combustion engines during May, according to figures from the Department of Commerce, were as follows: 359 Diesel and semi-Diesel engines valued at $130,976; 2,968 gas engines not over 8 hp. valued at $255,265; and 113 gas engines over 8 hp. valued at $72,251.

Argentina received the greatest number of the Diesel engines, 310, costing $117,800. Japan was the biggest user of the gas engines under 8 hp., taking 1,225, costing $100,220.

New Publications

Oil Flow Viscosity and Heat Transfer. By R. S. Danforth. Published by R. S. Danforth, San Francisco, Calif., 1923. Heavy board backs; 6x9 in; 16 pages; 11 charts. Price, $2.

This volume, which is companion to the author's work, "Oil Flow in Pipe Lines," shows the viscosity of crude oils from the more important fields. It is intended, primarily, for the designer of oil-pipe lines and pumping stations, since by using the charts the proper temperature required to maintain a given capacity is immediately ascertained. Of more general interest are the heat-transfer formulas for oil coolers and heaters. This is a subject concerning which heretofore little accurate data has been available.

The Design of Steam Boilers and Pressure Vessels. By George B. Haven, S. B., Professor of Machine Design, and George W. Swett, S. B., Associate Professor of Machine Design, both at the Massachusetts Institute of Technology. Published by John Wiley & Sons, Inc., New York City, January, 1923. Cloth; 6 x 9-in.; 435 pages; 206 figures, including two folding diagrams. Price, $4.

This is intended to teach rational design. The problems involved require a definiteness of the loads and the reliability of the materials employed in their construction, which forms a valuable incentive to intelligent application and accurate calculation, providing a desirable basis for the study of design work along broader lines. The first four chapters deal with general principles of boiler design, including descriptions of the quantities encountered, thermal boiler efficiency, styles of units, appliances, weights, circulation, as well as calculations suitable to the various steps in boiler design. A summary of the Massachusetts' boiler rules is included as well as standard specifications for boiler and firebox steel, rivet steel, etc., and an effort has been made to incorporate actual conditions with the design instruction as far as possible. In the last six chapters, complete designs for boilers and tanks of six different types are worked out completely from beginning to end. This new edition, revised from the original, contains the logical design of a water-tube boiler of the box-head type. The authors have sought to ascribe sound theoretical reasons for various proportions of water-tube boilers which have hitherto been reached solely by experience and precedent.

Radiator Traps. A preliminary report of the Committee on Research, National Association of Building Owners and Managers, Edison Building, Chicago. Published by the National Association of Building Owners and Managers, Edison Bldg., Chicago. Paper; 8½ x 11 in.; 68 pages; approximately 50 illustrations. Price, $5.

For those desiring information on steam-heating appliances, this book furnishes direct, practical and condensed information. Nine types of boilers are described, as well as four types of radiators and eight types of steam-heating systems. The trap of each manufacturer is reviewed with regard to material, and adjustments. Reports of tests on traps are included. On a memorandum of practical suggestions on the maintenance of a heating system, is mentioned a stethoscope for detecting the passing of steam through a trap or valve. As a compendium of practical advice this ranks at the top.

Technologic Papers of the Bureau of Standards, No. 235—Thermal Stresses in Steel Car Wheels, by George K. Burgess, physicist, and E. Williard Quick, associate physicist. Price, 15 cents. Government Printing Office, Washington, D. C.

Coming Conventions

American Chemical Society, Dr. Charles L. Parsons, 1709 G St. N. W., Washington, D. C. Convention at Milwaukee, Wis., Sept. 10-14.

American Institute of Electrical Engineers, F. L. Hutchinson, 29 West 39th St., New York City. Pacific Coast Convention at Del Monte, Calif., Oct. 2-5.

American Institute of Mining and Metallurgical Engineers; F. F. Sharpless, 29 West 39th St., New York City. 128th annual meeting at Toronto, Canada, Aug. 20, Quebec, Aug. 27, Montreal, Aug. 30.

American Society of Mechanical Engineers, Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Dec. 3-6.

American Society of Refrigerating Engineers, William H. Ross, 35 Warren St., New York City. Nineteenth Annual Convention at New York City, Dec. 3-5.

Association of Iron & Steel Electrical Engineers; J. F. Kelly, 1007 Empire Bldg., Pittsburgh, Pa. Iron and Steel Exposition at Buffalo, N. Y., Sept. 24-28.

Empire State Gas & Electric Association, Charles H. B. Chapin, Grand Central Terminal Bldg., New York City. Meeting at Lake Placid, N. Y., Oct. 8-9.

Illuminating Engineering Society, H. E. Mahan, Schenectady, N. Y. Convention at Fort William Henry Hotel, Lake George, N. Y., Sept. 24-28.

Indiana Electric Light Association, T. Donahue, Northern Indiana Gas & Electric Co., Lafayette, Ind. Meeting at French Lick Springs, Ind., Sept. 26-29.

International Union of Steam and Operating Engineers; Dave Evans, 6334, Yale Ave., Chicago, Ill. Annual convention at Detroit, Sept. 10-15.

National Association of Practical Refrigerating Engineers; Ed. H. Fox, 914-25 East Jackson Blvd., Chicago. Fourteenth Annual Convention at Memphis, Dec. 12-16.

National Association of Stationary Engineers; Fred W. Raven, 417 South Dearborn St., Chicago, Ill. Annual convention and exhibition at Buffalo, N. Y., Sept. 10-15. Annual conventions and exhibitions of the State Associations scheduled as follows: **Pennsylvania,** at Buffalo, Sept. 9-10; J. N. Calvert, Crafton Sta., Pittsburgh, Pa. **New York,** at Buffalo, Sept. 9-10; W. T. Meinzer, Third St., near Warburton, Bayside, L. I., N. Y.

National Exposition of Power and Mechanical Engineering; Charles F. Roth, Room 1102, Grand Central Palace, New York City. Power Show, Dec. 3-8.

National Safety Council, W. H. Cameron, 168 North Michigan Ave., Chicago, Ill. Twelfth annual congress at the New Statler Hotel, Buffalo, N. Y., Oct. 1-5.

New England Association of Commercial Engineers; James F. Morgan, 53 Devonshire St., Boston, Mass. Power Show at Mechanics Bldg., Boston, Mass., Oct. 29-Nov. 3.

New England Water Works Association; Frank J. Gifford, 715 Tremont Temple, Boston, Mass. Annual Convention at Burlington, Vermont, Sept. 18-21.

Society of Naval Architects and Marine Engineers, Daniel H. Cox, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 8-9.

West Virginia-Kentucky Association of Mine, Mechanical and Electrical Engineers; Herbert Smith, Room 211, Robson-Prichard Bldg., Huntington, W. Va. Third annual convention at Frederick Hotel, Huntington, W. Va., Oct. 19-20.

Society Affairs

The **American Association for the Advancement of Science** will hold a regional meeting at the University of Southern California, Los Angeles, Sept. 17-20.

The Iron & Steel Exposition to be held in Buffalo, N. Y., from Sept. 24 to 28 by the Association of Iron and Steel Electrical Engineers will have among other papers on its program the following: "Economical Use of Fuel in the Steel Plant," by H. C. Seibert, fuel engineer, Carnegie Steel Co.; "Electrically Operated Centrifugal Pumps," by B. A. Cornwell, electrical engineer, Carnegie Steel Co.; "Safety," by Walter Greenwood, safety engineer, Carnegie Steel Co.; "High Pressure Steam Boilers," by Dr. D. S. Jacobus, consulting engineer, The Babcock & Wilcox Co.; "Automatic Engine Stops," by Walter Greenwood, safety engineer, Carnegie Steel Co.; "The Tempering of Coal," by T. A. Marsh, chief engineer, Green Engineering Co.; "Surface Combustion," by W. H. Hepburn, vice-president, The Surface Combustion Co.; "Electrification of the Iron and Steel Foundry," by L. W. Egan, consulting engineer Cleveland, Ohio; "Boiler Troubles from the Operating Man's Standpoint," by Carl Smith, fuel engineer, Inland Steel Co.

Business Notes

The Engineering Appliance & Manufacturing Co., is being organized in St. Louis, Mo., by H. R. Rockwell, Charles F. Rauch and associates to manufacture a line of steam specialties.

The Power Specialty Co., manufacturers of Foster superheaters, economizers and oil heaters, announce that after Oct. 1, 1923 their Philadelphia office will be located in the Atlantic Building, Broad and Spruce Sts., Philadelphia, Pa.

Puget Sound Power & Light Co., a company under Stone & Webster management, has acquired control of the Olympia Light and Power Co., which supplies electric light and power and street railway service to Olympia, the state capital of Washington.

The Sterling Engineering & Manufacturing Corp. has taken over the business of the Templeton Manufacturing Co., manufacturer of Sterling return trap. The officers of the company are; C. G. Stebbins, president and sales manager; Paulsen Spence, vice-president and chief engineer; C. C. Tracy, treasurer and general manager. The main office will be at Hyde Park, Mass., with branches in various cities.

George B. Nichols, consulting engineer, 300 Madison Ave., New York City and **The Terrell Croft Engineering Co.**, of which Terrell Croft is directing engineer, of 6600 Delmar Boulevard, University City, St. Louis, Mo., have effected an affiliation whereby the experience and resources of each organization will be available to the clients of the other. Nichols will act as the principal for projects east of Illinois whereas the Croft organization will so act for projects west of that state. The combination will, as have its components in the past, specialize in mechanical and electrical engineering for power and industrial plants, institutions and buildings.

The Fuller Engineering Co. has consummated an agreement whereby it will act as sole licensee in the United States and Canada for all new business of the Quigley Fuel Systems, Inc. The engineering personal of the Quigley has become associated with the Fuller Engineering Co., and all business of the Quigley Fuel Systems, Inc., will in the future be conducted through the main and branch offices of the Fuller Engineering Co.

Trade Catalogs

Motors, Polyphase Induction—Allis-Chalmers Manufacturing Co., Milwaukee, Wis. Bulletin No. 1087D is a careful presentation of the design and operation of these large motors. Illustrations of installations and details of construction add to the clearness of the explanatory matter.

Motors, Induction—Reliance Electric & Engineering Co., Cleveland, Ohio. Bulletin No. 5018 describes Type AA induction motors for two-and three-phase alternating-current circuits. Cross-sections, tables of ratings and dimensions as well as photo reproductions illustrate the style and working of this motor.

Fans—American Blower Co., Detroit, Mich. The general catalog recently gotten out by this company contains much useful information in regard to exhausters, ventilating fans, air washers, blowers, engines and heaters. Illustrations and drawings as well as innumerable tables of dimensions, capacities and other data give value to the 102 pages contained in the catalog.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Aug. 13, 1923	Aug. 20, 1923
Pool 1,	New York	$3.00@3.50	$2.90@3.25
Smokeless,	Columbus	2.75@3.25	2.75@3.25
Clearfield,	Boston	2.00@2.75	2.00@2.75
Somerset,	Boston	2.25@3.00	2.25@3.00
Kanawha,	Columbus	1.75@2.00	1.75@2.00
Hocking,	Columbus	1.75@2.00	1.75@2.00
Pittsburgh No. 8	Cleveland	2.00@2.10	2.00@2.10
Franklin, Ill.	Chicago	2.75@3.00	2.75@3.00
Central, Ill.	Chicago	2.00@2.25	2.00@2.25
Ind. 4th Vein,	Chicago	2.50@2.75	2.50@2.75
West Ky.,	Louisville	1.50@1.85	1.65@1.85
S. E. Ky.,	Louisville	1.50@2.00	1.50@2.25
Big Seam,	Birmingham	1.75@2.25	3.40@3.65

FUEL OIL

New York—Aug. 23, light oil, tank car lots, 28@34 deg. Baumé, 4c. per gal.; 36@40 deg. 4¼c. per gal., f.o.b. Bayonne, N. J.

Chicago—Aug. 15, 24@26 deg. Baumé, $1.81½@1.86½ per bbl.; 32@36 deg., $2.01½@2.06½ per bbl., tank cars.

St. Louis—Aug. 21, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.80 per bbl.; 26@28 deg., $1.85 per bbl.; 28@30 deg., $1.95 per bbl.; 32@36 deg., gas oil, 4½c. per gal.; 36@40 deg., distillate, 4¾c. per gal.

Pittsburgh—Aug. 15, f.o.b. local refinery, 30@34 deg., fuel oil 4¼c. per gal.; 36@40 deg., fuel oil, 5c. per gal.; 34 deg., neutral 7¼c. per gal.

Dallas—Aug. 18, f.o.b. local refinery, 26@30 deg., $1.37 per bbl.

Cincinnati—Aug. 21, tank car lots f.o.b. local refinery, 26@30 deg. Baumé 4¼c. per gal.; 30@32 deg., 4½c. per gal.; 38@42 deg., distillate, 5¾c. per gal.

Philadelphia—Aug. 23, 28 deg., 4.5@4.75c. per gal.; 30@34 deg., 5c. per gal

New Plant Construction

PROPOSED WORK

Calif., Long Beach — The city voted $3,000,000 bonds bonds for the construction of a gas distributing system.

Calif., Los Angeles—Cahn-McCabe, 716 South Spring St., plans to build a 12 story, 50 x 80 ft. store and office building on 7th and Spring Sts.

D. C., Wash.—The Engineers Office, War Dept., Old Land Office Bldg., has had plans prepared for the construction of hydro-electric plant, filtration plant, reservoir and completion of conduits.

Fla., Orlando—The city will hold an election Sept. 4 to vote on bonds for the extension and improvement to waterworks and electric light plant.

Idaho, Lewiston—The city, J. R. Turnbull, Controller, will receive bids until Sept. 5 for waterworks improvements, including hydrants and valves; c.i. pipe; five motor driven, horizontal, centrifugal pumps consisting of three low service pumps, 1,600, 2,100 and 2,800 g.p.m., one high service pump, 2,100 g.p.m., and one filter wash pump, 500 g.p.m.; starters, starting panels and miscellaneous electrical equipment; complete equipment for four 1,500,000 g.p.d. filter units; pipe laying; one 3,600,000 gal. and one 4,000,000 gal. reservoir; construction of purification plant building, filter basins, mixing chamber, settling basins, filtered water reservoir, new intake lines, moving and re-setting present pumps and installing new pumps. Burns & McDonnell Eng. Co., 402 Interstate Bldg., Kansas City, Mo., Engrs.

Ill., Waukegan—The Callahan Dairy Co., 428 Franklin St., is in the market for pasteurizing and refrigerating machinery, several ton capacity.

Ia., Marion — Linn County, G. A. Senninger, Auditor, will soon award contract for the construction of a court house, also jail building with heating plant. Estimated cost $700,000 and $50,000 respectively. J. W. Royer, Urbana, Ill., Archt.

Ia., Washington—The city, S. J. Kellogg, Clk., will hold an election Sept. 6 to vote on $80,000 bonds for improvements to waterworks system, including 200,000 gal. elevated tank, pumping station, motor driven pumps, switchboard, etc. A. L. Mullergren, Gates Bldg., Kansas City, Mo., Engr. Noted June 26.

Kan., Herndon—The city will hold an election Sept. 11 to vote on $30,000 bonds for the construction of an electric light system and transmission lines. W. B. Rollins & Co., 521 Railway Exch. Bldg., Kansas City, Mo., Engrs.

Kan., Lawrence—The Bowersock Mills & Power Co. has had plans prepared for an electrical distribution system. Estimated cost $200,000. A. L. Mullgren, 555 Gates Bldg., Kansas City, Mo., Engr.

Kan., Scranton—The city voted $50,000 bonds for improvements to water system, including pump, pipe lines, etc.

Ky., Georgetown—The city plans to build an electric light plant. Estimated cost $40,000. Engineer or architect not selected.

Ky., Hazard—The Combs Hotel Co. plans to build a 4 story, 80 x 120 ft. hotel. Estimated cost $300,000. Engineer or architect not announced.

Ky., Louisville—The Rainbow Coal Co., 2935 Grand Ave., C. D. Saylers, Purch. Agt., is in the market for electric power equipment for coal mines.

Ky., Newport—The city is having plans prepared for the construction of a filtration plant and pumping station. Estimated cost $360,000 and $240,000 respectively. J. N. Chester Co., Union Bldg., Pittsburgh, Engr.

Ky., Paducah—The Magle Packing Co. is having plans prepared for the construction of a 2 story, 60x135 ft. meat packing plant. Estimated cost $75,000. M. P. Burt, Falls Bldg., Memphis, Tenn., Archt. Ice making and refrigerating plant will be installed.

Mich., Iron River—The Peninsular Power Co., 102 North Carroll St., Madison, Wis., is having plans prepared for the construction of a 1 story, 44 x 60 ft. power plant, here. Estimated cost $250,000. Mead & Seastone, Journal Bldg., Madison, Engrs. Noted Aug. 14.

Minn., Sleepy Eye—The city will receive bids until Sept. 4 for one centrifugal pump.

Minn., Winona—The State Bd. of Control, St. Paul, is having plans prepared for the construction of a 3 story, 200 x 210 ft. main building, including power plant and steam heating system, at the State Teachers' College, here. Estimated cost $572,000. C. H. Johnston, 715 Capitol Bank Bldg., St. Paul, Archt. Noted Dec. 26, 1922.

Mo., Hannibal—The city is having preliminary plans prepared for improvements and extensions to water system, including pumps, motors at main station, filtration plant, mains also high service reservoir with pumping equipment and connections at South Hannibal. Estimated cost $350,000. D. H. Maury, 304 South Dearborn St., Chicago, Engr.

N. J., Atlantic City — F. B. Off, Hotel Brighton, Illinois Ave., will receive bids until Sept. 23 for the construction of a 5 story, 41x46x55x72x96 x 118 ft. addition to hotel, including elevators and heating system. Cost between $400,000 and $500,000. L. Titus, Hotel Strand, Atlantic City, Archt.

N. Y., Ballston Spa—The Bd. of Supervisors of Saratoga County are voting on a hydro-electric development and water supply system for the Homestead Sanatorium, Saratoga County Tuberculosis Hospital. Estimated cost $50,000. Utilities Eng. Co., Inc., 467 Broadway, Albany, Engrs.

N. Y., New York—The Dept. of Welfare, Municipal Bldg., is having plans prepared for the construction of the Bronx Municipal Hospital on East 167th St, between Walton and Grand Aves. Estimated cost $750,000. City Eng. Dept., Engrs.

Ohio, Cleveland—The Lake Shore Land & Development Co., c/o S. H. Kleinman, Natl. City Bldg., plans to build an 8 story, 126 x 148 ft. store and apartment building, including steam heating system, on East 93rd St. and Carnegie Ave. Estimated cost $500,000. Engineer or architect not selected.

Ohio, Sandusky—The city plans the installation of mechanical stokers under two 200 hp. Keeler boilers at the water works pumping station. N. H. Jenson. Ch. Engr.

Okla. Slick—The city voted $89,000 bonds for the construction of two wells, pumps, elevated tank with tower, also distribution system. Gant & Baker, 1st Natl. Bank Bldg., Oklahoma City. Noted July 17.

Pa., Johnstown — The Masonic Temple Assn., Alma Hall, G. Reese, Chn. Bldg. Com., plans to build a 3 story, 140 x 200 ft. lodge building on Valley Pike and Linton St. Estimated cost $500,000.

Pa., Phila. — L. H. Cahan & Son, 1324 Walnut St., is having plans prepared for the construction of a 25 story hotel on Broad and Locust Sts. Estimated cost $10,000,000. H. E. Kennedy, c/o owner, Archt. Equipment detail not reported.

S. C., Lamar—The Comrs. of Public Wks., L. C. Munn, Secy., will receive bids until Sept. 12 for furnishing and installing c.i. mains, service mains, tower, tank, pumping machinery, reservoir, sewer pipe and septic tank. Estimated cost $65,000. Ryan Eng. Co., Arcade Bldg., Columbia, Engrs.

Tex., Edgewood—The city voted $55,000 bonds, $40,000 for waterworks improvement and plant, $15,000 for electric light plant.

Tex., Lubbock—The Texas Technical College, c/o A. G. Carter, Fort Worth, plans the construction of college buildings, here. Estimated cost $850,000. Engineer or architect not selected.

Tex., Mercedes—The city, J. J E. Haynes, Mayor, postponed election from Aug. 4 to a later date, to vote on $150,000 bonds for the construction of a power and water plant. Noted Aug. 7.

Wash., Mount Vernon—A. R. Moore has made application to M. Chase, Olympia, supervisor of hydraulics, for water appropriation in Swift Creek, near here. Plans include a concrete diversion dam, 30 ft. high, 160 ft. long on top, 100 ft. at the bottom with spillway over the rimrock; hydro-electric plant developing 5,000 hp., to cost $100,000.

Wis., Horicon—The city, c/o E. M. Higbee, Clk., is receiving bids for a steam heating plant for the City Hall. Private plans.

Wis., Kenosha — The Bd. Educ., E. F. Powers, Secy., is having plans prepared and will receive bids about Oct. 1 for the construction of a 3 story, 248 x 250 ft. senior high school building. Estimated cost $1,000,000. J. D. Chubb, 109 North Dearborn St., Chicago, Archt. Equipment detail not reported.

Wis., La Crosse—The city, c/o C. C. Congdon, City Hall, is having plans prepared for additional water supply, including wells, pumps, mains, etc. Alvord, Burdick & Howson, 8 South Dearborn St., Chicago, Engrs.

Wis., Madison — The Chicago & Northwestern Ry. Co., c/o B. R. Kulp, Division Eng., 201 South Blair St., is receiving bids for the construction of a 60x110 ft., 200 ton mechanical coaling station. Noted July 31.

Wis., Madison—The University of Wisconsin, M. E. McCoffery, Secy., is receiving bids for the construction of steam tunnels from the central heating station to the new Wisconsin General Hospital. Estimated cost $25,000. Private plans.

Wis., Menominee — The Bd. Normal Regents, W. J. Kettle, Secy., is having plans prepared for the construction of a power plant and switchboard, here. Estimated cost $74,460. J. C. White, c/o State Power Plant, Madison, Engr. Noted July 31.

Wis., Richland Center—L. Trager plans to build a 1 story, 60 x 90 ft. cold storage plant to replace the one which was destroyed by fire. Estimated cost $40,000. Engineer or architect not selected.

N. S., West Pubnico—The West Pubnico Trading, Ltd., R. N. d'Entremont, Dir., is in the market for machinery and equipment to freeze, pack, smoke, dry and preserve fish.

Ont., Creemore—The town is having plans prepared for a waterworks system, including c. i. mains, hydrants, valves, 3 stage electric pumps and reservoir. Cost between $25,000 and $40,000. James, Proctor & Redfern, 36 Toronto St., Toronto, Engrs.

Ont., Hamilton — The Hamilton Hydro-Electric Comn., King St., E., is having plans prepared for the construction of a substation. Estimated cost $50,000. B. H. Prack, 1 Main St., Hamilton, Engr. The owner is in the market for transformers, switches, lightning arrestors, bus bars, insulators and wire.

Ont., Niagara Falls—The Niagara Falls Arena, Ltd., is having plans prepared and will soon receive bids for the construction of a 1 story, 85 x 185 ft. ice arena. Estimated cost $150,000. F. Barber & Associates, Ltd., 45 Jarvis St., Toronto, Engrs. The owner is in the market for an artificial ice plant.

CONTRACTS AWARDED

Calif., Los Angeles—The Eighth & Olive Holding Co. awarded the contract for the construction of a 13 story, 55 x 168 ft. office building on 8th and Olive Sts., to the W. Simpson Constr. Co., Bank of Italy Bldg., Los Angeles. Estimated cost $600,000. Equipment detail not reported. Noted Aug. 14.

Calif., Los Angeles—The Taft Realty Co., 5751 Hollywood Blvd., awarded the contract for the construction of a 12 story, 120 x 137 ft. office building on Hollywood Blvd. and Vine St. to Edwards, Wildey & Dixon, Black Bldg., Los Angeles. Estimated cost $850,000. Equipment detail not reported. Noted Aug. 14.

Calif., Los Angeles—E. A. Wayt awarded the contract for the construction of a 13 story, 83 x 100 ft. community apartment house on 6th St. and Carondelet Ave. to the Richardson Bldg. and Eng. Co., 631 South Berendo St., Los Angeles. Estimated cost $700,000. Equipment detail not reported. Noted May 1.

Calif., San Jose—The County of Santa Clara awarded the contract for the construction of a power house on the county hospital grounds to D. J. Byron, 1249 Alameda, St., San Jose, $18,587; mechanical equipment exclusive of fire apparatus, to J. E. O'Mara, 218 Clara St., San Francisco, $78,166. Noted Aug. 21.

Calif., San Luis Obispo — H. H. Carpenter, representing owners, awarded the contract for the construction of a 5 story hotel to the Burck Constr. Co. 714 South Hill St., Los Angeles. Cost will exceed $250,000. Equipment detail not reported.

Mich., Detroit—P. R. Bierer, 381 West Grand Blvd., awarded the contract for the construction of an 8 story, 100x157 ft. hotel, including oil burning boilers and equipment, on East Columbia St., to the Bryant & Detwiler Co., 2336 Dime Bank Bldg., Detroit. Estimated cost $600,000. The contractor is in the market for vacuum and refrigerating equipment.

Mich., Detroit—The Book Estate, Book Bldg., awarded the contract for the construction of a 29 story, 151 x 220 ft. hotel, including steam heating equipment, on Michigan Ave. and Washington Blvd., to the Lynch Constr. Co., Room 1106, 1200 Washington Blvd.

Mich., Detroit—M. D. Caughey, 2323 East Grand Blvd., awarded the contract for the construction of an 8 story apartment house, including steam heating equipment, boiler and accessories, on East Grand Blvd. and Chene St., to the O. Misch Co., 159 Columbia Ave., Detroit. Estimated cost $1,000,000.

Mo., Joplin — The Methodist Episcopal Congregation, c/o J. F. King, 309 Moffet St., will build a 4 story, 60 x 100 ft. hospital at 2600 Nugent Ave. by day labor. Estimated cost $250,000. Equipment detail not reported.

N. J., Perth Amboy—The Standard Underground Cable Co., Westinghouse Bldg., Pittsburgh, Pa., awarded the contract for the design and construction of a 1,200 hp. boiler installation at its plant at 26 Washington St. here, to McClellan & Junkersfeld, Inc., 45 William St., New York.

N. Y., Eastview—F. L. Merritt, Clk. Bd. of Supervisors, Westchester County Court House, White Plains, awarded the contract for central heating plant to the Martin Corp., White Plains. Estimated cost $75,010.

N. Y., New York—The Masro Realty Co., c/o Springstein & Goldhammer, Engrs. and Archts., 32 Union Sq., will build an office building at 36 West 47th St. by day labor. Estimated cost $750,000. Equipment detail not reported.

Pa., Phila.—The Bd. of Trustees, University of Pennsylvania, 34th St. and Woodland Ave., awarded the contract for design and construction of a new boiler plant, initial installation 2,600 hp., on the Schuylkill River, to McClellan & Junkersfeld, Inc., 45 William St., New York.

Pa., Phila.—The Hawthorn Realty Co., 1619 Chestnut St., will build a 4 story, 115 x 176 ft. apartment house on 42nd and Walnut Sts. Estimated cost $500,000. C. E. Oelschlater, 1621 Walnut St., Archt. Equipment detail not reported. Owner is receiving bids on separate contracts.

Pa., Pittsburgh—The Bluefield Co., Farmers Bank Bldg., awarded the contract for alterations and a 10 story addition to Schenley Hotel on Forbes St., Bigelow Blvd. and 5th Ave. to the Mellon Stuart Co., Oliver Bldg., Pittsburgh. Estimated cost $500,000. Equipment detail not reported.

S. D. Flandreau—The city awarded the contract for waterworks improvements, including concrete well, c.i. pipe, construction of a 22 x 26 ft. pump house, one direct motor driven centrifugal pump, etc., to W. D. Lovell, 1415 Southeast 8th St., Minneapolis. Estimated cost $18,000. Noted July 31.

Tenn., Knoxville—The state, L. S. Pope, Dir. of Institutions, Nashville, awarded the contract for the construction of the Deaf & Dumb Institute buildings, including two dormitories, heating plant, school building, etc., here, to the V. L. Nicholson Constr. Co., Knoxville. Estimated cost $250,000.

Tex., Dallas—The Dallas Power & Light Co., Interurban Bldg., will build a power plant on North Dallas and Tuttle Sts., by day labor. Estimated cost $50,000. J. Oram, c/o Owner, Engr.

Tex., Houston—The Sam Houston Hotel Co., Prairie and San Jacinto Sts., awarded the contract for the construction of a 10 story, 100 x 100 ft. hotel to D. Hall, Carter Bldg., Houston. Estimated cost $600,000. Equipment detail not reported.

Wis., Wausaukee — Polomis Bros., F. Polomis, Mgr., will build a 2 story, 30x60 ft. ice cream factory and creamery by day labor. Estimated cost $40,000. The owner is in the market for refrigeration machinery, etc.

Ont., Ford—The Ford Motor Co. of Canada awarded the contract for the construction of a 112 x 148 ft. power plant to the S. E. Dinsmore Co., Windsor. Estimated cost $40,000. The owner is in the market for $1,500,000 worth of power machinery utilizing pulverized fuel and making use of byproducts plant, also boilers, pumps, motors, stokers, condensers and retorts. Noted June 19.

Ont., Timmins—The Hollinger Consolidated Gold Mines, Ltd., awarded the contract for two 12,500 hp., 60 head vertical turbines in connection with hydro-electric power installation at Island Portage on the Abitibi River. Total estimated cost of plant $4,000,000. Noted Aug. 7.

Ont., Whitby—The town awarded contracts in connection with extensions to waterworks system as follows: furnishing intake pipe to the Toronto Iron Wks., Royal Bank Bldg., Toronto, $6,000; laying of intake pipe to R. Carson, Midland; two centrifugal motor driven, 3 stage pumps to the J. Hepburn Co., 18 Van Horne St., Toronto.